4–6 Module

Unit 1
Managing and Conserving Natural Resources

Lesson 1
Defining Natural Resources

Lesson 2
Away to the Landfill

Lesson 3
Keeping Items Cycled

Lesson 4
Renewable and Nonrenewable Natural Resources

Lesson 5
Ways to Conserve Natural Resources

This unit was well received by the students as it made them aware of the role they must play in conserving natural resources. The lessons allow access for all types of learners and integrate many subject areas. The students enjoyed the activities, could see the impact of their decisions, and were eager to participate in projects to enhance their environment.

— Edward Malaret, fifth-grade teacher, Mary Silveira Elementary, Dixie Elementary School District

4–6 MODULE

Unit 1: Managing and Conserving Natural Resources

Overview

UNIT 1'S CONCEPTS

- Natural resources are the living and nonliving components that support life on Earth.
- While humans use natural resources to satisfy their needs, they should conserve all materials they consume.
- Natural resources can be reused and recycled into new and useful products.

The five lessons in this unit are described in the outline that follows.

LESSON 1: DEFINING NATURAL RESOURCES

Lesson's concepts:

- Natural resources are things from the natural environment, such as plants, animals, soil, minerals, energy sources (e.g., sunlight, fossil fuels), air, and water. They are the living and nonliving components that support life on Earth.
- While humans use natural resources to satisfy their needs, they should conserve all the materials they consume.

In Lesson 1 students will:

- Make journals.
- Observe and record information on natural resources found on the school grounds.
- Listen to the story *Just a Dream* by Chris Van Allsburg, and identify categories of natural resources described in the story.
- Compare scenes in *Just a Dream* by Chris Van Allsburg to those that could have represented a natural environment before it was changed by people.
- Work as a class to develop a rubric to assess the projects they will be completing.
- Design a project by selecting a natural resource to research, gathering information from different sources for a report, and making a mobile or collage on ways that the specific natural resource is used by people.
- Present their projects to the class.

LESSON 2: AWAY TO THE LANDFILL

Lesson's concepts:

- Solid wastes are made from a variety of natural resources. Once these wastes are placed in a landfill, they are no longer available to be reused or recycled, and the natural resources used to make them are wasted.
- Landfills are the most common sites used for waste disposal.
- Landfills take up space and are located in areas that are, or once were, habitats for people, wildlife, and other living things.
- Modern landfills are designed to protect the environment.

In Lesson 2 students will:

- Construct in a bottle a model of a landfill.
- List what goes into a landfill and determine what happens to the natural resources used in objects that end up in a landfill.
- Demonstrate that waste takes up space in a landfill and that some waste can be diverted from a landfill by being reused or recycled.
- Classify items in their models of landfills according to what can be reduced, reused, or recycled.
- Observe over time the changes occurring in the waste in their models of landfills.
- Analyze school waste that has been placed in a landfill.
- Discuss alternatives to putting school waste in a landfill.

LESSON 3: KEEPING ITEMS CYCLED

Lesson's concepts:

- Everything people make, use, and discard comes from natural resources.
- Most products made by people can be kept out of landfills and kept in a cycle through reusing and recycling.

In Lesson 3 students will:

- Classify objects they brought to class according to the category of natural resources from which the objects were made.
- Develop a list of questions to find out what natural resources were used and the steps that it took to make a particular object.
- Work in groups to do the necessary research to answer their list of questions about an object they select and the ways that object can be kept out of a landfill.
- Determine how reusing or recycling extends the "life cycle" of an object.
- Present to the class their reports on how to keep an object out of a landfill.

LESSON 4: RENEWABLE AND NONRENEWABLE NATURAL RESOURCES

Lesson's concepts:

- Renewable natural resources are those which can be replaced naturally or through human-assisted actions within a relatively short amount of time (e.g., within a human lifetime). Examples of renewable natural resources are plants, animals, water, air, and some energy resources, such as sunlight.
- Nonrenewable natural resources are those available in limited amounts and take millions of years to be replaced; therefore, people can rely only on those deposits already in existence. Examples of nonrenewable natural resources are most minerals (e.g., iron ore) and some energy resources (e.g., fossil fuels).

In Lesson 4 students will:

- Determine which natural resources are considered renewable and which are considered nonrenewable.
- Classify items found in the outdoors and in the classroom as being made from renewable natural resources, nonrenewable natural resources, or both types of resources.
- Write a pledge to avoid wasting one specific material at school or at home.
- Design posters or a bulletin board featuring pictures of renewable and nonrenewable natural resources.

For Part I younger students (grade four) will:

- Identify the location of some mineral reserves, such as bauxite, iron ore, and tin.
- Read a chart to determine how long certain mineral resources are likely to last.

For Part II older students (grades five and six) will:

- Search the classroom for various colored beads that represent finite mineral resources.
- Compare the numbers acquired in a simulation game to the actual global reserve base of specific mineral resources.
- Analyze charts and graphs concerning mineral resources.
- Arrange in order some mineral resources that are most abundant to those that are less abundant.

LESSON 5: WAYS TO CONSERVE NATURAL RESOURCES

Lesson's concepts:

- Reducing, reusing, and recycling materials help to conserve natural resources.
- The quality of the lives of future generations may depend on people's use of natural resources today.

In Lesson 5 students will:

- Write a letter from the viewpoint of a person living in the future, thanking this generation for conserving natural resources.
- Conduct a class meeting to obtain and select ideas to conserve natural resources in the classroom.
- Write an advertisement or design a poster to encourage people to conserve natural sources.
- Implement the plan they agreed on to conserve natural resources in the classroom.
- Identify some ways that natural resources can be conserved at the entire school.

Required Books to Implement Unit 1

- **For Lesson 1:**

  Van Allsburg, Chris. *Just a Dream*. Boston: Houghton Mifflin Company, 1990.

- **For Lesson 5:**

  Why the Sky Is Far Away. Retold by Joan-Mary Gerson. New York: Little, Brown and Company, 1992.

PROJECTS

Projects provide hands-on experiences for students. Some lessons in Unit 1 are project-based and encourage students to apply what they have learned in the classroom. Some project-based lessons are service-learning oriented in which students participate in improving the environment in their school and community. For more information on projects and project-based learning, see "Tips for Implementing Projects" at the beginning of this curricular guide.

The following are descriptions of projects and examples of schools that have completed projects that address this unit on managing and conserving natural resources. Teachers are encouraged to help students select one of these projects or to have their students develop one of their own. If students implement an applicable project, they and their teachers are encouraged to send a description of the project to the Office of Integrated Education, MS-14A, California Integrated Waste Management Board, 1001 I Street, P.O. Box 4025 (mailing address), Sacramento, CA 95812-4025.

- **Project 1:** Students select a natural resource in their community and develop a plan to share its importance with community members. (Lesson 1)
- **Project 2:** Students research the location of the landfill where their garbage goes and identify any nearby streams or other bodies of water. They find out the source of their community's drinking water. If the landfill is not located in their community, students can find out the source of the drinking water of the community in which the landfill is located. They discuss how the landfill might impact the community's drinking water. (Lesson 2)
- **Project 3:** Students collect and analyze water samples of surface water surrounding a landfill. They share their results with community members. (Lesson 2)
- **Project 4:** Students bring in clean pieces of old clothes and braid a class throw rug. (Lesson 3)
- **Project 5:** Students write a class pledge that describes how to avoid wasting natural resources. They organize a school assembly and share the pledge along with information about natural resources.

Top of the World Elementary School, Laguna Beach Unified School District[1]

Fourth- and fifth-grade students in Sandy Gravely's class at the Top of the World Elementary School have organized school assemblies where they shared pledges that describe how to help the environment and distributed recycling bags for students to use to clean the campus. They also set up a mini-landfill in a glass aquarium and demonstrated how to make 100 percent recycled paper. The class also donated their time by participating in a beach cleanup. As part of their research, the class surveyed local restaurants regarding recycling and offered to help establish a recycling program for the restaurants if they were interested.

- **Project 6:** Students design posters or a bulletin board showing pictures of renewable and nonrenewable natural resources and ways they can be conserved. These can be displayed at school and in other public areas. (Lesson 4)
- **Project 7:** Students develop and implement a plan to reduce waste at school. (Lesson 5)
- **Other Projects**

Monterey Road Elementary School, Atascadero Unified School District[2]

Students in Dian Shervem's fifth-grade class raised money through a recycling program they initiated at their school. With the money raised, along with donations from parents and local businesses, the class purchased trees and planted them on the school grounds. Then they built and installed

[1]"Jiminy Cricket's 1997–98 Environmentality Winners." E-mail from Deidra Bennett, Senior Environmental Programs Representative, Environmental Policy, The Walt Disney Company, Inc., October 15, 1998.

[2]"Jiminy Cricket's Environmentality Heroes 1994–97." Burbank, Calif.: The Walt Disney Company, Inc., and the State of California's Environmental Education Interagency Network, 1999, p. 29.

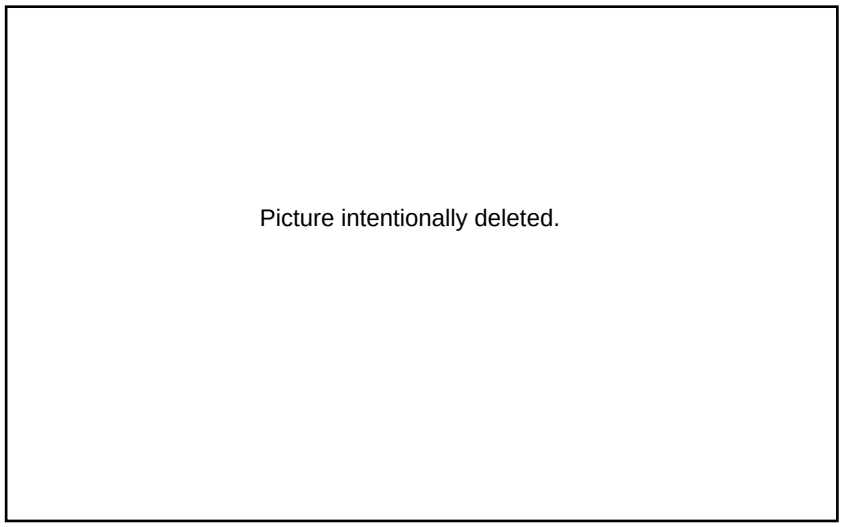
birdhouses in the trees. Their actions provide habitat to wildlife.

Ridgeview Elementary School, Yucaipa–Calimesa Joint Unified School District[3]

Students in Susan Ramsay's fifth-grade class learned about the potential hazardous effects of landfills to the groundwater. They began a recycling program to reduce the amount of trash going to the landfill. They began educating others by producing a video, which included two songs they wrote. They also planted a tree on the school grounds.

Note: See "Appendix F–1, Awards and Activities websites" for ideas for projects.

[3]"Jiminy Cricket's Environmentality Heroes 1994–97." Burbank, Calif.: The Walt Disney Company, Inc., and the State of California's Environmental Education Interagency Network, 1999, p. 28.



Two students from Janet Cohen's sixth-grade class at Gold Trail Elementary School braid pieces of cloth to make a throw rug.

LESSON 1: Defining Natural Resources

LESSON'S CONCEPTS

- Natural resources are things from the natural environment, such as plants, animals, soil, minerals, energy sources (e.g., sunlight, fossil fuels), air, and water. They are the living and nonliving components that support life on Earth.
- While humans use natural resources to satisfy their needs, they should conserve all the materials they consume.

PURPOSE

Students learn about natural resources and the products people make from these resources. Students also prepare for the unit by making journals.

OVERVIEW

In this lesson students will:

- Make journals.
- Observe and record information on natural resources found on the school grounds.
- Listen to the story *Just a Dream* by Chris Van Allsburg, and identify categories of natural resources described in the story.
- Compare scenes in *Just a Dream* by Chris Van Allsburg to those that could have represented a natural environment before it was changed by people.
- Work as a class to develop a rubric to assess the projects they will be completing.
- Design a project by selecting a natural resource to research, gathering information from different sources for a report, and making a mobile or collage on ways that the specific natural resource is used by people.
- Present their projects to the class.

CORRELATIONS TO CALIFORNIA'S CONTENT STANDARDS AND FRAMEWORKS

- Students identify categories of natural resources, conduct research on a specific natural resource, and determine ways humans acquire and use natural resources.
  - "Humans use air, fresh water, soil, minerals, fossil fuels, and other sources of energy that come from the Earth. " (*Science Framework*, page 97)
  - "They (people) farm the soil, mine resources from the Earth, and get energy by burning fuels, including wood, which is also used to make paper and to build." (*Science Framework*, page 125)
  - "Sources of energy and materials differ in amounts, distribution, usefulness, and the time required for their formation. As a basis for understanding this concept, students know . . . (the) natural origin of the materials used to make common objects." (*Science Content Standards, Grades K–12*; Grade 6; Resources, Standard 6c)
- Students write a report about a specific natural resource, obtaining information from several sources.
  - Students "create multiple-paragraph expository compositions." (*English–Language Arts Content Standards for California Public Schools, Kindergarten Through Grade Twelve*, page 30)
- Students present their reports and displays and listen to presentations by other students.
  - "Students listen critically and respond appropriately to oral communication. They speak in a manner that guides the listener to understand important ideas by using proper phrasing, pitch, and modulation." (*English–Language Arts Content Standards for California Public Schools, Kindergarten Through Grade Twelve*, page 26)

SCIENTIFIC THINKING PROCESSES

observing, communicating, comparing, classifying

TIME

15 minutes to prepare for the lesson; 45–60 minutes to implement the lesson, plus 30–45 minutes three times a week for students to work on their projects over a three-week period

VOCABULARY

energy sources, natural resources

PREPARATION

___ **1.** Read the "Background Information for the Teacher" at the end of this lesson.

___ **2.** Make a copy of the "Student's Natural Resource Information Sheet" for each student (pages 254-255).

MATERIALS

___ Pocket folders for each student (If you plan to have students make their own journals, see "One Way to Make Your Own Journal" on page 252.)

For "Part I, Learning About Natural Resources and Reading* Just a Dream *by Chris Van Allsburg"

___ The book, *Just a Dream* by Chris Van Allsburg

For "Part II, Conducting Research About Natural Resources"

___ A copy of the "Student's Natural Resource Information Sheet" for each student

___ Magazines that would contain pictures of products made from natural resources

___ Coat hangers (or pieces of cardboard), poster paper or butcher paper or used file folders, art supplies, scissors, glue, and yarn for making mobiles and collages

PRE-ACTIVITY QUESTIONS

A. Tell students that they will each make a journal. In the journal they will write and draw information about what they are studying. Students should know that people write and draw in journals to record observations, thoughts, ideas, and information about certain topics.

B. Provide a pocket folder and ten sheets of paper for each student. (If you do not have access to pocket folders, students can make their own folders by following the directions in "One Way to Make Your Own Journal.") To model reusing (and therefore conserving) paper, distribute paper that was used on one side.

C. Lead students outdoors and ask them to identify items that come from the natural environment (nature). Ask students to draw and describe in their journals five different items that come from nature that they saw (e.g., animals, plants) or felt (e.g., air) on the school grounds.

D. Back in the classroom, discuss what students observed.

PROCEDURE

Part I, Learning About Natural Resources and Reading *Just a Dream* by Chris Van Allsburg

A. Tell students that things that come from the natural environment are called *natural resources.* Natural resources are what all living things need in order to live. Ask students to identify some categories of natural resources. *Plants, animals, soil, minerals (rocks), energy sources (e.g., fossil fuels, sunlight), water, and air.* (You might need to provide students with hints to help them with some of the answers.)

B. Ask students to point out something in the classroom (or outside the classroom) that can represent each of the categories of natural resources.

C. Discuss with students:

- Which of these natural resources are living and which are nonliving? *Plants and animals are living; minerals, fossil fuels, sunlight, water, and air are nonliving; soil can be both, because fertile soil is full of microscopic organisms, in addition to rock particles and dead plant and animal parts.*
- What types of products do people make from natural resources? *Television sets, cars, houses, books, paper, shoes, belts, leather, pencils, plastics.*

D. Read to students or allow different students to read parts of the book *Just a Dream* by Chris Van Allsburg.

1. Ask students to determine categories of natural resources described. For example:
   - Landfill—*soil*
   - Forest—*plants (trees)*
   - Smokestack—*air; fossil fuels*
   - Mountain—*minerals*
   - Ocean—*water, animals (fish)*
   - Freeway—*fossil fuels*
   - Grand Canyon—*minerals*
   - Duck—*animals*
2. Discuss with students which scenes could have represented a natural environment before it was changed drastically by people. What natural resources would have been there?
   - Landfill—*habitat for plants and animals (including people); clean air and water*
   - Forest—*plants and animals, habitat for plants and animals, clean air and water*
   - Smokestack—*clean air*
   - Mountain—*mountain, minerals, plants and animals, habitat for plants and animals, clean air and water*
   - Ocean—*ocean, plants and animals, habitat for plants and animals, clean air and water*
   - Freeway—*natural environment that used to be there, plants and animals, habitat for plants and animals, clean air*
   - Grand Canyon—*canyon, plants and animals, habitat for plants and animals, clean air and water*
   - Duck (wetland)—*animals, wetland that used to be there (habitat for plants and animals)*

E. Discuss with students how people can improve some environments (e.g., plant flowers, clean up litter, repair eroded areas, build buildings that blend into the environment, design parks and playground areas).

F. Ask students whether they think that people are part of nature. Help students to conclude that people are classified as "animals" and are therefore part of the natural environment (nature). People, like all other living things, are dependent on all the natural resources that exist on Earth. Once people recognize their dependence on natural resources, they may wish to conserve these resources.

Part II, Conducting Research About Natural Resources

Note: In this part of the lesson, only five categories of natural resources will be featured, because these are the natural resources from which most products are manufactured.

A. Tell students that they will be conducting research on a specific natural resource and will complete a project, which will include making a mobile or collage. With the class, develop a rubric on how each project will be judged. See the example at the end of this lesson. Students might decide to use this lesson's rubric as is or change it. Make certain that all students understand clearly what they are expected to do. As a class, agree on a timeline. A reasonable amount of time for students to complete the project is approximately three weeks.

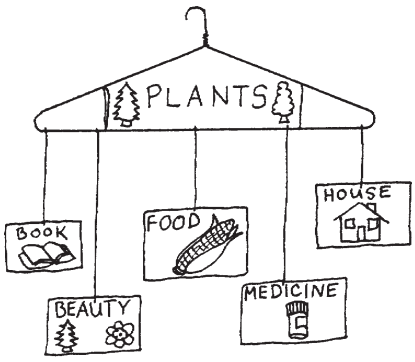
B. Provide a copy of "Student's Natural Resource Information Sheet" for each student. Ask students to select one of the following natural resources: plants, animals, soil, minerals (rocks), or fossil fuels; and to circle the name of the resource on their sheets. Tell them that they will need to do the following:
- Conduct research on the natural resource they have selected. They should find out what products people make from this natural resource and how it is gathered from the natural environment. They should also include ways this natural resource is used or admired in its natural state (without manufacturing products out of it). For example, when minerals are not mined, they might be part of a mountain where people hike and enjoy the natural environment.
- Write a multi-paragraph text that presents effective introductions and concluding paragraphs that guide and inform the reader's understanding of key ideas and evidence concerning the natural resource selected.
- Make a mobile or collage of items made from this natural resource. For example:
  - For the mobile, students can write the name of a natural resource, glue a picture of the natural resource in

its natural state, and attach it to the hanger or piece of cardboard. They can draw and/or cut out pictures from magazines of products that are made from this natural resource and hang these from the hanger or piece of cardboard.

- For the collage, students can draw a line down the middle of a piece of poster paper, butcher paper, or a used file folder. They can glue pictures or draw the natural resource in its natural state on one side of the paper (or folder). On the other side of the paper (or folder), they can glue cutout pictures, showing products made from the natural resource.

• Include, on the mobile or collage, ways that the natural resource is used or admired in its natural state (i.e., without manufacturing products from it).

Note: Individually, students can complete the information sheet and report. Then they can work in small groups to make a mobile or collage, so that only two or three mobiles or collages would be made for each category of natural resources.



C. Allow some class time for students to work on their projects. If possible provide them with access to the internet. Once students have completed their projects, they should present these to the class. The class can help determine where each project fits on the rubric, based on the work presented.

D. If some students complete their projects before others are finished, ask them to make a list, on a piece of butcher paper, of products in someone's home that are made from plants (includes trees). Review and post this list before assigning the homework assignment.

Picture intentionally deleted.

Students from Nona Reimer's fifth-grade class at John Malcom Elementary School use the internet to gather information about natural resources.

Homework Assignment: Ask students to describe in writing a typical morning when they are getting ready to go to school or a typical evening at home. Then they should rewrite what their morning or evening would be like if no products made from plants were in their homes.

DISCUSSION/QUESTIONS

A. What have you learned about natural resources? (Answers will vary.)

B. Why are natural resources important? *They provide us with things we need in order to live.*

C. What natural resources are most important to you and why? (Answers will vary.) For example, students might say that air and water are most important because they cannot live without them. Students should conclude that all natural resources are important.

APPLICATION

A. Display on a bulletin board and/or compile in a class book the work that students have completed on natural resources.

B. Have the students make a bulletin board of different types of trash and the natural resources used to make the trash.

C. Ask students to draw on the covers of their journals a scene from a natural environment (e.g., desert, ocean, forest, marsh). Have them include examples of natural resources from each category.

Project Idea: Have groups of students select a natural resource in their community and develop a plan to share its importance with community members.

EXTENSIONS

A. Have students make a collection of minerals (usually in rock form) and conduct research on the ways people use them.

B. Have students make a photo album of scenes of natural environments (e.g., forest, pond, ocean, marsh), showing natural resources in their natural state. Students could also collect nature scenes from magazines and outdated calendars and make a scrapbook out of these.

C. Use the book, *The Secret Life of School Supplies* by Vicki Cobb, to identify the natural resources used in the manufacturing of school supplies.

RESOURCES

Video

Conserving Our Natural Resources. Chatsworth, Calif.: AIMS Media, 1979 (15 minutes)

Describes natural resources and the importance of conserving them.

Books

Cobb, Vicki. *The Secret Life of School Supplies*. Illustrated by Bill Morrison. New York: HarperCollins Publishers, 1981.

Provides information on school supplies, such as paper, writing instruments (chalk, pencils, pens), and adhesives. Simple experiments students could do with each item are described.

Van Allsburg, Chris. *Just a Dream*. Boston: Houghton Mifflin Company, 1990.

A story about a boy who dreams about a future after natural resources were not used wisely. After the dream, the boy decides to do what he can to care for natural resources.

Websites

See "Appendix F–IV, Natural Resources websites."

Picture intentionally deleted.

Students from Oak Valley Elementary School use the internet to gather information about natural resources.

ONE WAY TO MAKE YOUR OWN JOURNAL

Supplies Needed

___ 12- by 18-inch tagboard or construction paper (two sheets for each student)

___ Stapler

___ Three-hole paper punch and brass fasteners (three for each student). If these are not available, the pages can be stapled.

___ Lined and unlined paper (15 sheets per student: 5 lined and 10 unlined) To model reusing, use paper that has been used on one side.

Directions

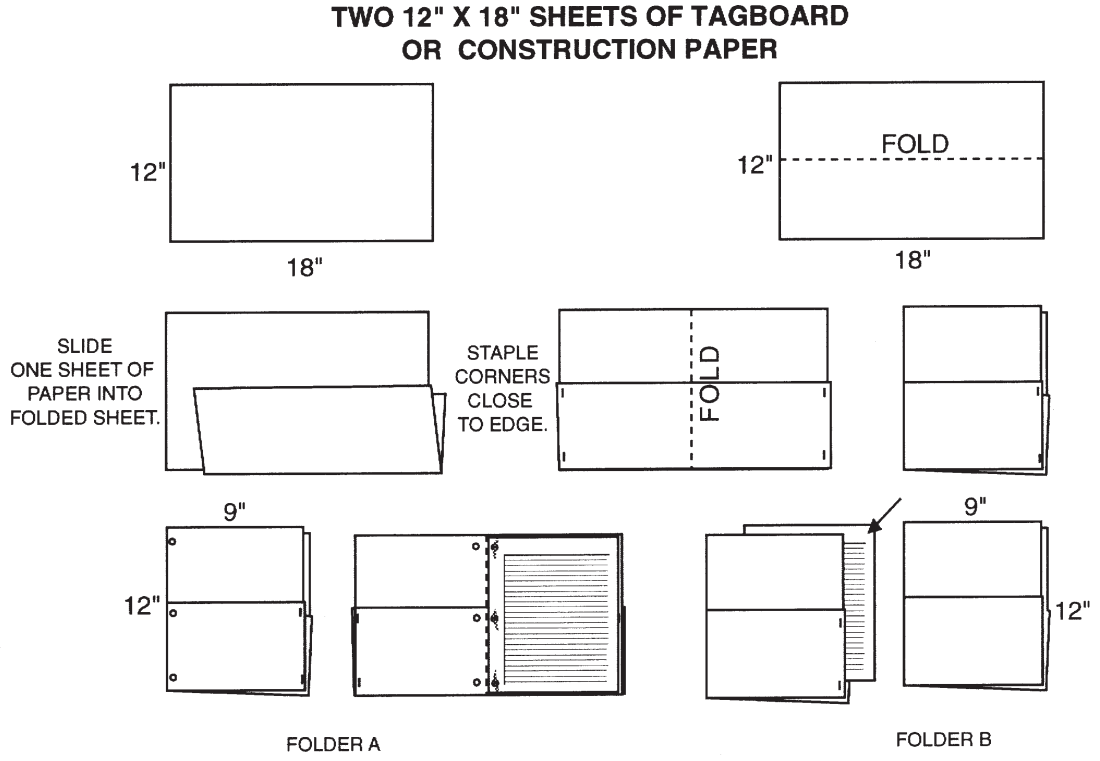
1. Distribute two sheets of 12- by 18-inch tagboard or construction paper to each student.

2. Have students make their journals by doing the following (see illustrations below):

- Fold one sheet of tagboard or construction paper in half lengthwise.
- Slide one sheet of paper into the folded sheet.
- With the folder open, staple the left side and the right side of the folded sheet onto the unfolded sheet, as close to the edge as possible. The folded sheet will make pockets on the inside and outside of the front cover.
- Fold the entire journal cover in half so it closes like a book.

3. **A.** If you have brass brads, punch three holes in the left margin with a three-hole punch. (See Folder A.) Place the brass fasteners through the back of the folder and through the lined and unlined pages but not through the front cover. This will make the front cover easier to open.

B. If you do not have brass brads, staple the journal pages to the journal cover. (See Folder B.)



Rubric for the Natural Resources Project

RUBRIC FOR THE NATURAL RESOURCES PROJECT

	1. Select a natural resource and complete the information sheet.	1. Select a natural resource and complete the information sheet.	1. Select a natural resource.
	2. Conduct research on the natural resource selected. Use at least three different sources and list the sources in the report.	2. Conduct research on the natural resource selected. Use at least two different sources and list the sources in the report.	2. Conduct research on the natural resource selected. Use at least one source of information and list the source in the report.
	3. Identify the products that people make from this natural resource and list at least five of these.	3. Identify the products that people make from this natural resource and list at least three of these.	3. Identify the products that people make from this natural resource and list at least one of these.
	4. Describe how the natural resource is gathered from nature and write at least one paragraph about this.	4. Describe how the natural resource is gathered from nature and write at least two sentences about this.	4. Describe how the natural resource is gathered from nature and write at least one sentence about this.
	5. Write at least one paragraph about the ways this natural resource is used or admired in its natural state.	5. Write one paragraph about the ways this natural resource is used or admired in its natural state.	5. Write one sentence about the way this natural resource is used or admired in its natural state.
	6. Make a mobile or collage and include a written report consisting of an introduction, one middle paragraph, and a concluding paragraph that guide and inform the reader's understanding of key ideas and evidence of the information gathered in items 2–5 above.	6. Make a mobile or collage and include a written report of the information gathered in items 2–5 above.	6. Make a mobile or collage.
	7. Present the materials to the class.	7. Present the materials to the class.	7. Present the materials to the class.

Student's Page

STUDENT'S NATURAL RESOURCE INFORMATION SHEET

1. Select and circle one of the following natural resources that you want to research: plants, animals, soil, minerals (rocks), fossil fuels.

2. Conduct research on the natural resource you have selected. Use different sources to get information and list the sources in your report. If you use books or magazine articles, be sure to include the author, title of reference, year of publication, and page numbers of the information.

Sources I used:

3. What products do people make from this natural resource?

4. How is this natural resource used or admired in its natural state (without making a product out of it)?

5. How is this natural resource gathered from the natural environment?

6. Make a mobile or collage, include a written report of the information gathered in items 2–5 above, and present your project to the class.

BACKGROUND INFORMATION FOR THE TEACHER

Many products we use every day come from the Earth's natural resources. Natural resources are things that come from the natural environment and are the living and nonliving components that support life on Earth. They can be classified according to seven categories: plants, animals, soil, minerals, energy sources (e.g., sunlight, fossil fuels), air, and water. There are, however, other definitions for *natural resources*. Some dictionaries and textbooks define natural resources as raw materials or forms of energy in the natural environment that are useful to *people*. For example, "any portion of our natural environment—soil, water, rangeland, forest, wildlife, or minerals—that human beings can use to promote their welfare is a natural resource."[1] Another definition of *resource* states, "substances that support life and fulfill human needs . . ."[2] A more ecological definition of natural resources would be: things in the natural environment that support life on Earth (whether or not they are valuable to people). Some people also separate natural resources into three groups: (1) those raw materials found in the natural environment (e.g., minerals, trees); (2) human-made materials (e.g., glass, paper pulp); and (3) recycled material (e.g., cullet or crushed glass ready to be remanufactured; recycled paper). In this unit, natural resources are defined as the things in the natural environment that support life and are used by people to live and to make products.

Natural resources are required by all living things; therefore, humans are totally dependent on natural resources, such as air, water, plants, and animals, for their survival. Some natural resources are used as the raw materials for many products that people manufacture. For example, iron ore is a raw material classified as a mineral. People use iron ore to manufacture steel. Steel is used to make cars, appliances, and many other products. Trees are raw materials classified as plants. People use trees for lumber to build houses and other structures; they also use soft-wooded trees to grind into pulp to make paper.

Obtaining and using natural resources affect the environment. The extraction or harvesting of natural resources has an impact on the habitats of plants and animals that live there. The manufacturing of products from natural resources can create air, land, and water pollution; and many natural resources used to make products often end up in a landfill.

In this unit, natural resources are classified according to seven categories. The category of energy sources can be further subdivided into sunlight, fossil fuels, and other energy sources (e.g., wind, hydropower). The seven categories of natural resources and ways that people depend on these categories of natural resources are briefly described below.

PLANTS—Plants are living things that can produce their own food. Trees, shrubs, grasses, seaweed, and some microscopic algae are examples of plants. Green plants produce oxygen. They also produce their own food through the process of photosynthesis. Many animals depend on plants for food.

Humans breathe the oxygen that plants make, and they use plants for food, clothing, medicines, and shelters. They also use wood to heat their homes. Humans use plants to beautify an area, to keep soil from eroding, to make lumber for houses, and to serve as windbreaks.

ANIMALS—Most animals can be defined as living things that differ from plants, rely on other organisms for food, and can move and respond rapidly to stimulation. Animals have a nervous system and can usually move on their own. Examples of types of animals are: mammals (includes humans), birds, reptiles, amphibians, fish, and invertebrates, such as insects, spiders, and worms. Some microscopic living things, including single-celled protozoans, are also classified as animals.

Humans use animals for food, clothing, education (e.g., animal behavior), companionship, and aesthetic purposes; e.g., bird watching. The manure of some domesticated animals is used as fertilizer. Humans also use animal products in medicines.

[1]Oliver S. Owen, *Natural Resource Conservation*. New York: Macmillan Publishing Co., 1985, p. 12.

[2]Linda Schwartz, *Earth Book for Kids.* Santa Barbara, Calif.: The Learning Works, Inc., 1990, p. 182.

SOIL—Soil is a mixture of minerals from weathered rock and decaying plant and animal matter. It also consists of microscopic living things, such as bacteria and fungi. Most plants that live on land need soil in which to grow. Soil provides water and nutrients to plants. Many animals live on or in soil.

Humans use soil in which to grow plants for food and on which to build roads, houses, other buildings, and landfills. They also use soil in products, such as adobe bricks.

MINERALS—Minerals are naturally occurring *inorganic* substances that originally came from rock. Inorganic means "being or composed of matter other than plant or animal."[3] Examples include phosphorous, bauxite, iron, salt, gold, silver, copper, mercury, and potassium. Many minerals are essential for the healthy growth of plants, animals, and other living things. Most plants absorb the minerals that are dissolved in water through their roots. Animals must obtain their required minerals by eating plants or by eating other animals that have eaten plants.

Humans use minerals to manufacture thousands of different items. Silica is used to make glass; bauxite is used to make aluminum; and many minerals are used to make items, such as cars, computer parts, cooking utensils, and appliances. Humans also need certain minerals in order for their bodies to function properly. They get these minerals from the food they eat.

AIR—Animals need oxygen in air (or water, in the case of aquatic animals) to breathe, and plants use carbon dioxide in air (or water, in the case of aquatic plants) in the process of photosynthesis. The gases are recycled through plants and animals. Air that is not clean can make organisms (living things) sick.

WATER—Water is used by plants during the process of photosynthesis. Animals drink or absorb water to maintain body functions. Some animals live in water, and some use it as a source of food, as a means of protection, or as an air conditioner. Fresh water on land is replenished by the water cycle and is essential to all living things. Water that is polluted can make organisms sick.

ENERGY SOURCES

• Sunlight—The energy derived from sunlight is used by green plants for photosynthesis to make sugars, which are then used as a source of chemical energy for growth and maintenance. This energy is transferred to animals through food chains. Sunlight also powers the water cycle by evaporating water from the land and from surface waters, and it creates wind energy through alternate heating and cooling of the atmosphere. People depend on sunlight to provide energy for plants to live and grow. People depend on plants for food, fiber, building materials, and fuel. Solar energy is also used to heat homes and to produce electricity.

Note that "sunlight" is not addressed in this curricular guide, because the focus of the lessons is on the connections among natural resources, manufactured items, and the management of solid waste.

• Fossil Fuels—Fossil fuels include crude oil, coal, and natural gas. Technically, fossil fuels are not classified as minerals because they are *organic* in origin, originating from partially decayed plants that lived millions of years ago. *Organic* refers to materials that consist of molecules containing carbon and were once part of a living thing.

Humans use fossil fuels as a source of energy to generate electricity or to move machinery. The entire transportation system is dependent on petroleum products. Humans use petroleum and natural gas to make plastics from which many items are manufactured. Petroleum is also used in making many commonly used products, such as fertilizers, lubricating fluids, cosmetics, and pesticides.

• Other Energy Sources—Other energy sources include wind power, hydropower, geothermal energy, and tidal energy. These are not, however, addressed in this curricular guide.

In this lesson students are not only introduced to categories of natural resources but also to the methods for gathering information on natural resources for projects that they will present later to the class.

[3]*Merriam-Webster's Collegiate Dictionary* (Tenth edition). Springfield, Mass.: Merriam-Webster, Inc., 1994, p. 603.

[4]*Merriam-Webster's Collegiate Dictionary* (Tenth edition). Springfield, Mass.: Merriam-Webster, Inc., 1994, p. 932.

The word *project* can sometimes be confusing. For the purpose of this lesson, a *project* is defined as a "task or problem engaged in usually by a group of students to supplement and apply classroom studies."[4] Usually, students plan and design the projects. They might research information through direct experience or by reading about or listening to the experiences of others. They might work individually, in pairs, in small groups, or as a class. As a result of their participation in projects, the students are more likely to learn more, enjoy the process of learning, and be well on the way to become life-long learners. A variety of projects and, when available, examples of classes and schools implementing such projects are described in the overview of each unit.

A more formal approach to implementing projects is called *project-based learning*. For more information on project-based learning, see "Tips for Implementing Projects" at the beginning of this curricular guide.

LESSON 2: Away to the Landfill

LESSON'S CONCEPTS

- Solid wastes are made from a variety of natural resources. Once these wastes are placed in a landfill, they are no longer available to be reused or recycled, and the natural resources used to make them are wasted.
- Landfills are the most common sites used for waste disposal.
- Landfills take up space and are located in areas that are, or once were, habitats for people, wildlife, and other living things.
- Modern landfills are designed to protect the environment.

PURPOSE

Students learn how landfills are constructed to protect the environment. They will conclude that once objects are placed in a landfill, these objects can no longer be used; and, therefore, the natural resources used to make the objects are wasted.

OVERVIEW

In this lesson students will:

- Construct in a bottle a model of a landfill.
- List what goes into a landfill and determine what happens to the natural resources used in objects that end up in a landfill.
- Demonstrate that waste takes up space in a landfill and that some waste can be diverted from a landfill by being reused or recycled.
- Classify items in their models of landfills according to what can be reduced, reused, or recycled.
- Observe over time the changes occurring in the waste in their models of landfills.
- Analyze school waste that has been placed in a landfill.
- Discuss alternatives to putting school waste in a landfill.

CORRELATIONS TO CALIFORNIA'S CONTENT STANDARDS AND FRAMEWORKS AND TO *BENCHMARKS FOR SCIENCE LITERACY*

- Students construct a landfill model in a bottle to learn how landfills are constructed to protect the environment.
  - "(People) need to exercise judgment, care, and planning in their use of natural resources . . . and in their practices of disposing of wastewater and materials." (*Science Framework*, page 125)
  - "Public landfills must be planned responsibly . . .." (*Science Framework*, page 97)
  - "To develop geographic literacy, students must: . . . Understand human and environmental interaction." (*History–Social Science Framework*, page 16)
- Students categorize classroom waste items into those that can be reduced, reused, or recycled.
  - "Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept . . . Students will classify objects . . . based on appropriate criteria . . .." (*Science Content Standards, Grades K–12*; Grade 5; Investigation and Experimentation, Standard 6a)
  - "Discarded products contribute to the problem of waste disposal. Sometimes it is possible to use the materials in them to make new products, but materials differ widely in the ease with which they can be recycled." (*Benchmarks for Science Literacy*, page 189)
- Students describe what they see when they go on an imaginary tour of a landfill. They discuss the pros and cons of landfills.

- "Students listen critically and respond appropriately to oral communication. They speak in a manner that guides the listener to understand important ideas by using proper phrasing, pitch, and modulation." *(English–Language Arts Content Standards for California Public Schools, Kindergarten Through Grade Twelve,* page 26)

SCIENTIFIC THINKING PROCESSES

observing, communicating, ordering, classifying

TIME

45–60 minutes to prepare; 60 minutes to implement the lesson; plus time to examine the contents of the landfill in a bottle one month later

VOCABULARY

landfill

PREPARATION

___ **1.** Read the "Background Information for the Teacher" at the end of this lesson.

___ **2.** Contact the waste manager or local recycling coordinator (check the telephone directory, or call the California Integrated Waste Management Board's Office of Integrated Education at (916) 341-6769 to get the phone number for your city's or county's solid waste department, which is often part of the Department of Public Works in your community). Ask for information about the nearest landfill. If possible, have the coordinator send you photographs of, and other information concerning, the landfill. Also, ask whether the coordinator is willing to come to speak about solid waste to the class or to set up a field trip.

___ **3.** If possible, arrange to take students to visit a local landfill or take slides or make a video of the landfill to show to the class.

___ **4.** Obtain the video, *Kids Talking Trash,* available from the California Integrated Waste Management Board.

___ **5.** Ask students to bring in a two-liter beverage container and a plastic grocery bag.

___ **6.** If needed, precut the two-liter bottles to prepare them for students to use. See "Procedure," section "B."

___ **7.** Make transparencies of "Construction of a Landfill in a Bottle" (page 267); "Layers in a Landfill in a Bottle" (page 268); "Diagram of a Landfill" (page 269); and "Waste Stream from Schools" (page 270)

MATERIALS

___ A trash can of clean classroom waste
___ Plastic tarp or cloth sheet on which to spread out the waste
___ Piece of butcher paper on which to make a chart
___ A photograph, book, or video (e.g., *Kids Talkin' Trash)* that shows a landfill
___ Two rinsed two-liter beverage containers and caps for each pair of students
___ One plastic grocery bag for each pair of students
___ A one-gallon bucket of garden soil (Do not use sterilized potting soil.)
___ A one-gallon bucket of gravel
___ Scissors, tape, two rubber bands, and utility knives
___ Assorted small pieces of clean nonhazardous waste between one-half and one-inch long (e.g., pieces of apple cores, banana peels, bread pieces, leaves, aluminum foil, bottle caps, rubber bands, pennies, pieces of cloth, plastic toy, newspaper, copy paper, and plastic scraps) (Use some materials from the classroom's trash can.)
___ Clay soil (if necessary, garden soil mixed with clay to give the soil a clay-like texture); approximately one half-cup per two-liter beverage container
___ A pair of plastic or garden gloves for each pair of students
___ Transparencies of "Construction of a Landfill in a Bottle," "Layers in a Landfill in a Bottle," "Diagram of a Landfill," and "Waste Stream from Schools"

PRE-ACTIVITY QUESTIONS

A. Spread the garbage from the classroom trash can on a plastic tarp or cloth sheet for students to see. Ask students:

- What should we do with this waste or trash? *Throw it in a garbage can. Throw it away.*
- What happens to our trash when we throw it in a garbage can? *The garbage company picks it up.*
- After the garbage company picks it up, where is it taken? *To dump; to a landfill.*

B. Make a chart labeled "What Goes in a Garbage Can?" on a piece of butcher paper. Ask students what goes in a garbage can, and list their responses on the chart. Keep this chart to use at the end of this lesson.

What Goes in a Garbage Can?

- *Paper*
- *Food scraps*
- *Tin cans*
- *Candy wrappers*
- *Gum wrapper*
- *Plastic food containers*
- *Milk jugs*
- *Grass clippings*
- *Leaves*
- *Old clothes*
- *Aluminum cans*
- *Diapers*
- *Styrofoam*
- *Broken toys*

Submitted by Janet Cohen's sixth-grade class, Gold Trail Elementary School, Gold Trail Union School District.

C. Have students complete the following sentence in their journals: "I put my garbage in a garbage can; then it goes . . ." Prompt students with the following questions:

1. What happens to the garbage after it is placed in a garbage can?
2. Who moves it?
3. How does it get in the garbage truck?
4. Where does the garbage truck take it?
5. What happens to the garbage then?

D. Ask students to share their journal entries.

- Discuss where most garbage ends up. *In a landfill.*
- Ask whether anyone has seen a landfill and encourage students to describe one.
- Show photographs, read sections of a book, or show a video about landfills.

E. If possible, have the local waste manager or recycling coordinator come and speak to your class.

Note: Keep the waste from the classroom and use some of it in the models of landfills.

Picture intentionally deleted.

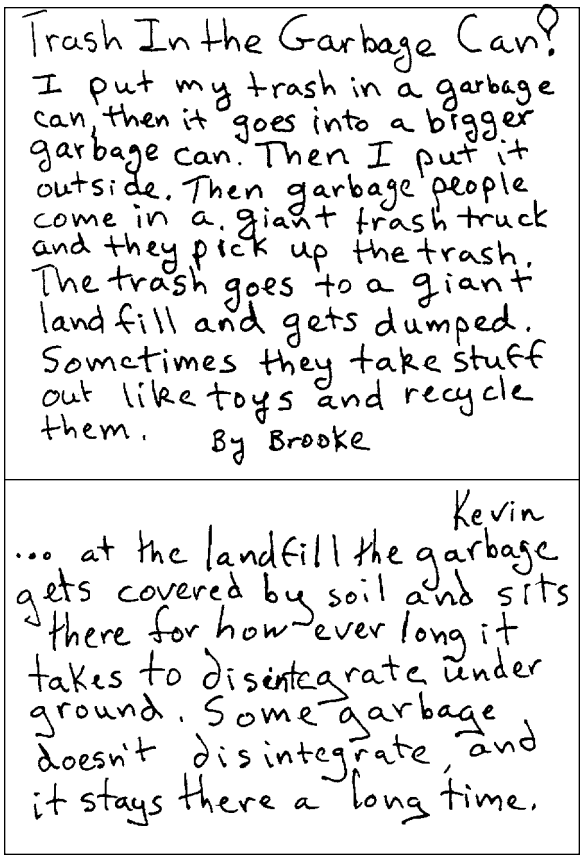
Students from Valley Oak Elementary School look at garbage from a garbage can.

PROCEDURE

A. Tell students that they will be building landfill models in bottles to learn more about the construction requirements for landfills. Provide two 2-liter bottles for each pair of students.

B. The following are directions for preparing the bottle for the landfill model in a bottle. To help you prepare the bottles, see "Construction of a Landfill in a Bottle" in this lesson. Cut two 2-liter bottles, as shown in the diagram:

- Cut Bottle B 9 inches from the cap. For safety, make an incision with the utility knife and then let the students cut around the bottles with scissors (for younger children, the 2-liter bottles will need to be precut). If the edges are jagged, trim them with scissors and place masking tape over them.
- The base of Bottle A will be the base of the landfill.


Trash In the Garbage Can?
I put my trash in a garbage can, then it goes into a bigger garbage can. Then I put it outside. Then garbage people come in a giant trash truck and they pick up the trash. The trash goes to a giant landfill and gets dumped. Sometimes they take stuff out like toys and recycle them. By Brooke

... at the landfill the garbage gets covered by soil and sits there for however long it takes to disintegrate under ground. Some garbage doesn't disintegrate, and it stays there a long time. Kevin

Submitted by Ed Malaret, fifth-grade teacher, Marguerite Hahn Elementary School, Cotati–Rohnert Park Unified School District.

- Leave the screw top on Bottle B.
- Turn the top portion of Bottle B upside down and place it on top of the base.
- After filling the landfill, you will place the top of Bottle A on top of the inverted Bottle B to form the cap.
- Recycle the bottom portion of Bottle B.
- Place a cup of gravel in the bottle to represent an aquifer. An *aquifer* consists of rock, sand, or gravel which stores groundwater.
- Place ½ cup of soil (about 2 inches) on top of the gravel in the bottle to represent the ground.

C. Show the transparency "Layers in a Landfill in a Bottle." Tell students that all new landfills require clay soil, a heavy (60 mil HDPE) plastic liner, gravel, and soil to be placed on the ground before waste is added. Note that in most new landfills and those that are being expanded, a geotextile cushion is placed above the plastic liner and below the crushed rock or gravel to keep the rocks from piercing the liner. A geotextile cushion is a soft, waterproof, approximately ¼-inch thick material that looks like outdoor carpet. Some of these cushions have a layer of rigid plastic netting sandwiched between soft material. Sometimes a geotextile cushion is placed on top of the crushed rock or gravel to keep the soil from mixing with the rock. In some landfills, a geotextile cushion is also placed below the plastic liner. In this lesson the geotextile cushions were omitted in the landfill in a bottle to make it easier for the students to build the model.

- Have students place the following materials in the order listed:
  - A layer of clay soil about 1 inch high on top of the existing soil
  - A plastic liner over the clay soil
  - A layer of gravel over the liner
  - A layer of soil over the gravel
- Ask students why they were asked to place clay soil, a plastic liner, gravel, and soil in the bottle before they added the waste. *To keep the waste from contaminating the soil.*
- If needed, explain to students that when it rains, the water can go right through the landfill and mix with the waste. Then this polluted water can percolate through the soil and pollute the groundwater. So before the waste is dumped in a new landfill, a layer of clay soil, a liner of plastic, gravel, and more soil must be added. The clay soil and liner help to keep the water that seeped through the waste from reaching the groundwater. Some cities and counties are also expanding their landfills. All of these expansions require a layer of clay soil, a plastic liner, gravel, and additional soil to be placed before any waste is added.

D. Provide clean pieces of waste to students. Ask students to:

- Record in their journals the type of waste they plan to place in their landfill models.
- Place the pieces of waste on top of the soil, piling the waste about two inches high.
- Cover the garbage with ½-inch layer of soil (see "Layers in the Landfill in a Bottle").

- Add a second layer of garbage and top it with a 1-inch layer of soil.

E. Ask students why the garbage is covered with soil at the end of the day. *To keep garbage from being moved by the wind; to keep it from creating an odor; to keep animals away from it.*

F. Ask students to predict how the garbage would change in four or more weeks.

G. With the class, compile a list of items that were placed in the landfill. Have students identify natural resources from which each item was produced.

H. Show the first part of the video *Kids Talking Trash*. Discuss what the video says about landfills.

Homework Assignment: Ask students to use descriptive words to name the landfill that they designed. They should also describe why they selected that name. (They should write more than "I liked the name.")

I. Ask students to share with the class the names they selected for their landfills.

DISCUSSIONS/QUESTIONS

A. Discuss with students:

- What is waste? *Anything that people don't want*.
- Where do all the products we buy come from? *Natural resources*.
- Where do all the products go when we no longer want them? *Mostly to landfills*.
- When does an object become waste? *When it becomes spoiled, ruined, dirty, ugly, broken, old, no longer useful.* Make sure that students understand that once an object is thrown into a landfill, the object can no longer be used. The natural resources used to make the object end up in the landfill and are therefore wasted.
- What is valuable? *Whatever you think is important.* When does a new thing lose its value? *When someone who has it doesn't want it anymore; when it breaks or becomes soiled; when it gets old.*
- What can be done with things we no longer want, instead of throwing them into a trash can? *They can be given to someone else; reused; made into something else; recycled.*

Picture intentionally deleted.

Students from Nona Reimer's fifth-grade class at John Malcom Elementary School construct a model landfill in a bottle.

- Do you think landfills are a good idea? *Yes/No* If students say yes, ask them to explain. *We need landfills—a place where items that can't be reused or recycled can be thrown away*. If students say no, ask them what the alternative is. Where will people put their garbage? *They can recycle it or reuse it. They can try not to make garbage.* Can everything be either reused or recycled? *No.*
- Would most people want a landfill built next door to their homes? Why or why not? Where do we find areas for landfills? *Usually in areas where people do not live.* What is usually present in these areas*? Plants, animals, ecosystems.*
- Consider the distance that garbage trucks will need to travel to get to a landfill. What natural resources do trucks use to transport trash? *Fossil fuels.*

B. Discuss as a class the pros and cons of placing waste in landfills.

- Some pros to putting waste in landfills are listed below:
  - Garbage needs to go somewhere, and a landfill can handle large

amounts of waste, keeping it away from where people live.

- Placing garbage in a landfill is an easy way to dispose of unwanted items.
- The garbage is better contained in a landfill.
- The landfill keeps other places waste-free.
- A landfill can be designed to protect the environment.

- Some cons to landfills are listed below:
  - A landfill takes up space where an ecosystem existed and makes it impossible for people and wildlife to use the land.
  - A landfill is ugly.
  - Heavy equipment working in a landfill create noise and dust.
  - A landfill might pollute groundwater.
  - Landfills can create unpleasant odors and attract insects and rodents.
  - Materials that end up in a landfill are usually no longer available for people to use.

Note: If some concepts about landfills are not familiar to your students, you may want to introduce them briefly at this point or cover them in other lessons.

APPLICATION

A. Project the transparency of a "Diagram of a Landfill." Ask students to compare their landfills in bottles to the diagram of a landfill. Discuss what is similar and what is different.

Note: In the "Diagram of a Landfill," a "geotextile cushion" is added between the crushed rock and the liner. This keeps the rocks from piercing the liner. Above the crushed rock, another geotextile cushion keeps the soil from mixing with the rock. In this lesson the geotextile cushions were omitted in the landfill in a bottle to make it easier for the students to build the model.

Homework Assignment: Ask students to select an object discarded in a trash can. Ask them to describe how the object was made, what natural resources were used to make the object, how this object was used, why it ended up in the trash, and what will happen to it now. They can write this from the object's "point of view."

B. Ask students to share their homework assignments.

C. Introduce students to the waste management hierarchy listed below. Explain to students that because of the energy savings and the amount of natural resources conserved, this hierarchy serves as a way of setting up priorities for dealing with waste.

1. Reducing and reusing
2. Recycling and composting, including buying products made from recycled materials
3. Environmentally safe transformation (waste to energy) and environmentally safe land disposal (landfilling)

D. Ask students to focus on the chart, "What Goes in a Garbage Can?" developed at the beginning of this lesson. Ask students to tell you, as you circle items using different colored markers, which items on the chart could be reduced (i.e., used more sparingly in the first place), reused, or recycled. The chart can be used for reference, as a record of changes as the students learn more, and as an assessment tool.

E. Project a transparency of "Waste Stream from Schools." Ask students to look at the "Schools" column and to indicate what natural resources each came from. Then have them identify which could be reduced, reused, or recycled.

Project Idea: Have groups of students research the location of the landfill where their garbage goes and to identify any nearby streams or other bodies of water. Have them find the source of their community's drinking water. If the landfill is not located in their community, have students find out the source of the drinking water of the community in which the landfill is located. Then discuss with students how the landfill might impact the community's drinking water.

Project Idea: Have groups of students collect and analyze water samples of surface water surrounding a landfill. They should share their results with community members.

At least four weeks later

A. Provide plastic or garden gloves to each pair of students and have them sort through their landfills. Discuss with students:

1. What was the condition of the items when they were removed from the

model landfills? Was anything rotting? Explain to students that garbage placed in landfills usually does not rot because there is not enough air and moisture to help things to decompose. (The topic of decomposition is addressed in the 4–6 Module, Unit 3.)

2. Was it easy to take the trash out of the students' landfills and to separate it? Would it be easy or difficult to try to separate the trash from a real landfill? What would be some problems? Explain to students that some communities have a materials recovery facility (MRF) where all types of garbage are separated before the non-recyclables are transported to a landfill. However, once the garbage has been covered with soil in a landfill, it is very difficult and would be very expensive to try to remove all the items that could be reused and recycled. Therefore, it is more efficient to separate the recyclable and usable materials before the trash is buried in the landfill.

Note: For more information and a lesson on MRFs, see the 4–6 Module, Unit 2, Lesson 8, and Appendix B–III.

3. What items in the models of landfills (including the containers themselves) should be reused, recycled, or put in a landfill after this lesson? For example, most communities recycle the two-liter PETE bottles (polyethylene terephthalate); organic wastes, such as banana peels and leaves, can be composted/mulched; pennies can be reused; newspaper can be recycled/mulched; aluminum can be recycled; cloth can be reused or, if made from cotton, silk, wool, or other all-natural fiber, can be mulched or composted.

B. Keep these models of landfills to use in the 4–6 Module, Unit 4, Lesson 2, when students will learn more about leachate and what household waste should not go into a garbage can and end up in a landfill.

FIELD TRIP

Take students on a field trip to see their local landfill, transfer station, or MRF. If your community has a transfer station, explain to students its purpose. A transfer station is a place that is usually located closer to residential and commercial areas than a landfill. Waste is temporarily stored there and then loaded on large trucks and hauled to the landfill.

If a field trip is not possible, consider taking slides or making a video of the landfill and show these to the class; or invite the local waste manager or recycling coordinator to visit the class and bring slides or a video of the landfill.

When observing a landfill, students should realize that it would be quite difficult to separate trash once it is placed in the landfill.

A landfill in Sonoma County.

A landfill in Sonoma County. In the background the day's garbage is being covered with soil. In the foreground compost is available for sale.

VARIATION

Have students weigh the garbage before they place it in their model landfills. Then once they have removed the garbage and separated it, have students calculate the total weight for items that could be reused, those that could be recycled, and those that need to be placed back in the landfill. This will indicate how much garbage, by weight, can be diverted. Trucks with garbage are weighed at the landfill and their drivers pay to dump their garbage, based on the weight of the garbage.

Note: In a landfill the volume of materials is more important than the weight, because it is the volume of garbage that takes up space. Have students figure out how they can measure the volume (i.e., how much space the garbage takes up) of their garbage.

EXTENSIONS

A. Ask students to make a map of current and former landfills in the community. Ask if they can think of reasons why landfills might be placed in certain areas (e.g., areas of low population, areas designated for industrial use) and what a landfill's impact might be on the surrounding community.

B. Ask students to draw and label what they can do to keep more garbage out of the landfill.

RESOURCES

Videos

Bill Nye the Science Guy: Garbage. Elk Grove Village, Ill.: Disney Educational Products, 1995. (50 minutes)

In addition to other information about waste, Bill Nye shows that garbage usually does not decompose in a landfill.

Garbage, Garbage, Garbage. The Green Earth Club series. Produced by TV Ontario, 1992 (15 minutes). Chatsworth, Calif.: AIMS Media (distributor).

Shows a landfill site and explains what usually happens to garbage after it leaves our homes.

It All Adds Up (Waste/Pollution). The Outside Story with Slim Goodbody series. Produced by Agency for Instructional Technology (AIT) and the Slim Goodbody Company, 1991 (15 minutes).

Stresses the importance of dealing with waste responsibly and shows various ways in which humans dispose of waste. Encourages students to reduce, reuse, and recycle as much of the waste they create as possible.

Kids Talkin' Trash. San Leandro, Calif.: Alameda County Waste Management Authority, 1995 (14 minutes). Sacramento: California Integrated Waste Management Board (distributor).

Students learn how to make less garbage and protect the environment by practicing the four R's: reduce, reuse, recycle, and rot. Shows a landfill.

Books

Amos, Janine. *Waste and Recycling*. Chatham, N.J.: Raintree, 1992.

Discusses what waste is and how it can be recycled.

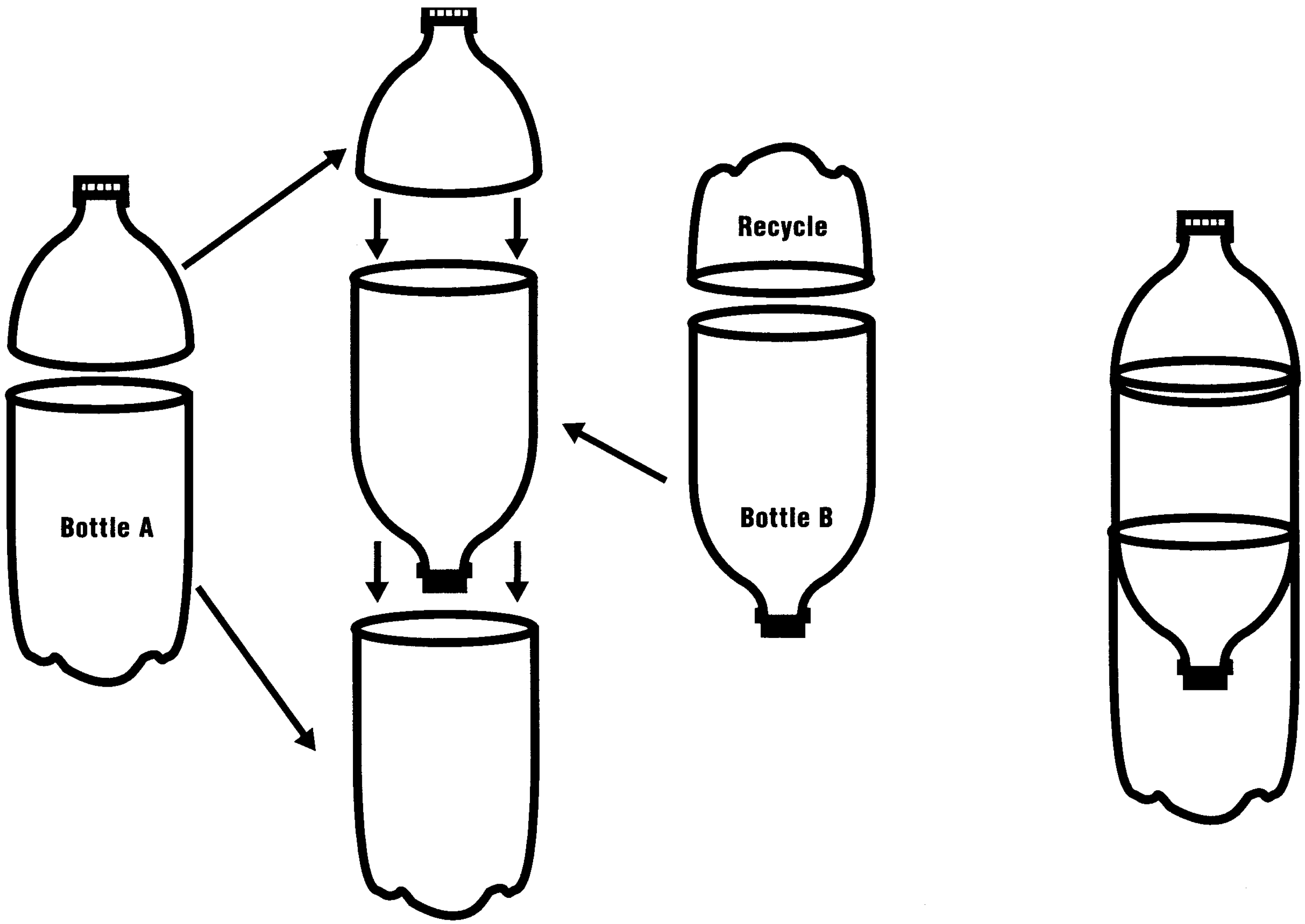
Bottle Biology Resources Network. "Compost Column." Madison: University of Wisconsin, March 1990.

Website

See "Appendix F–III, Landfill websites."

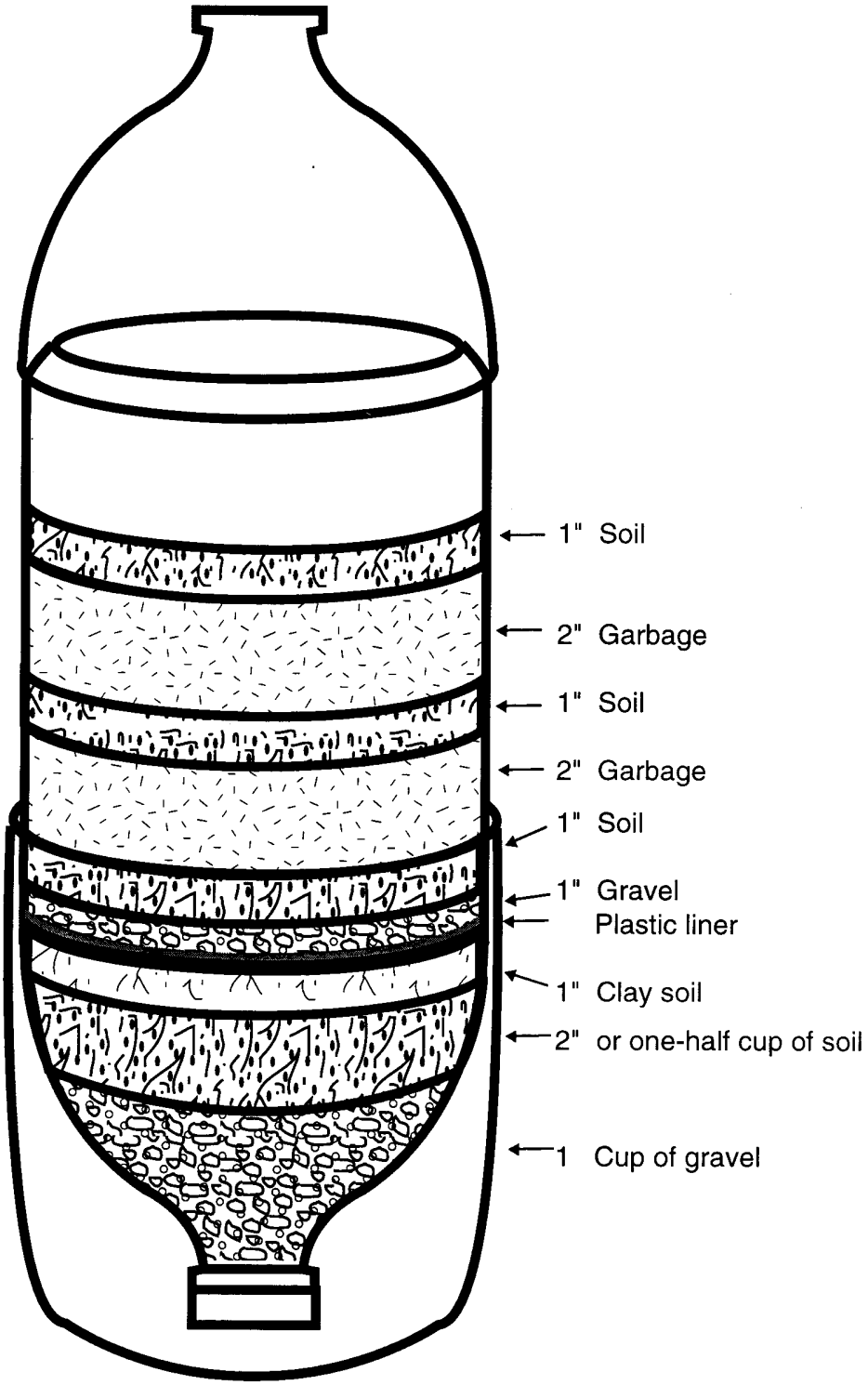
Transparency

CONSTRUCTION OF A LANDFILL IN A BOTTLE



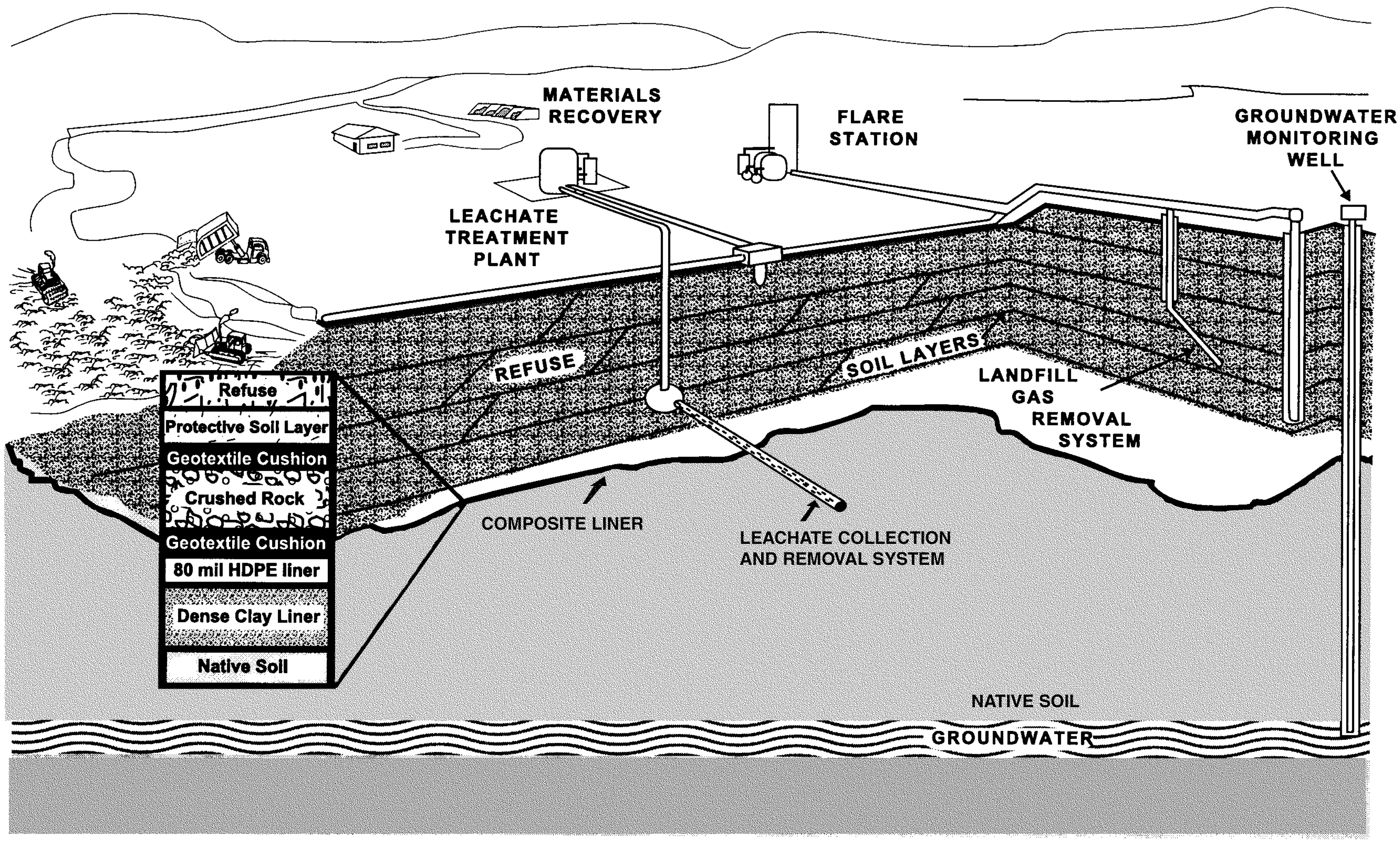
Transparency

LAYERS IN A LANDFILL IN A BOTTLE



Transparency

DIAGRAM OF A LANDFILL



4–6 Module
Unit 1

Transparency

WASTE STREAM FROM SCHOOLS[1]

Material	Schools' waste (percent by composition)	Major category of natural resources used to make this product.	Can this item be reduced, reused, recycled, composted?
For example: **PAPER**	total: 53.9%	*plants*	*reused*
Corrugated/Kraft	2.2%		
Newspaper	0.6%		
Office paper	1.9%		
Mixed paper	16.2%		
Other	33.0%		
GLASS	total: 1.1%		
Clear bottles/containers	1.0%		
METAL	total: 2.6%		
Ferrous metals	0.9%		
Nonferrous metals	0.3%		
Other	1.4%		
PLASTIC	total: 11.9%		
HDPE	0.6%		
PET	0.2%		
Film plastic	7.4%		
Other plastic	2.7%		
Other	1.0%		
OTHER ORGANIC	total: 26.8%		
Food	22.9%		
Yard/landscape	3.5%		
Other	0.4%		
OTHER INORGANIC	0.5%		
HOUSEHOLD HAZARDOUS WASTE	2.6%		
MIXED RESIDUE	0.5%		

[1]City of Los Angeles 1995 Waste Composition Sampling Table 4-9, "Disposal Composition for Education–Public Primary/Secondary Target."

BACKGROUND INFORMATION FOR THE TEACHER

In 1997 Californians generated approximately 52.5 million tons of garbage. Only 32 percent of the discarded materials were recycled and composted.[2] The rest of the discarded materials were thrown "away." But where is this "away"? For most people in California, "away" is the landfill where, in 1997, 68 percent of the waste (including some discarded materials that could have been reused or recycled) was dumped. But the discarded materials in a landfill do not go away. They occupy space in the landfill. Materials buried in a landfill decompose slowly, because the conditions are not ideal for rapid decomposition by decomposers, many of which need oxygen and moisture. (For more information about decomposers, see the 4–6 Module, Unit 3, Lesson 2.) Note that some decomposers, such as anaerobic (those that do not need oxygen) bacteria also decompose garbage in a landfill. Some drier parts of a landfill are "mummified" for awhile, but as time goes by moisture in the site moves around to different locations and decomposition takes place. What takes five or ten years in a wet landfill to decompose might take 30 to 50 years in a dry landfill site.[3]

A landfill is not the best place for garbage that can be reduced, reused, or recycled. Instead of reusing objects or using waste materials to make new products, some communities bury waste materials in landfills, and they are potentially lost to those communities forever. Furthermore, all of the natural resources and energy used to make the items that are now in a landfill are wasted and are no longer available to people and other living things. Unburying and separating items for reuse or recycling would be cost-prohibitive at this time.

In addition, large areas of land are used for landfills. These areas were once ecosystems, providing habitats for wildlife and plant life. Also, people could have used the areas for a variety of purposes, such as parks or home sites.

However, landfills are essential, because people need a place to put their garbage where it will be contained and kept from contaminating the environment. Landfills are required by law to incorporate special design features to protect the environment. For example, the landfill operators must conduct methane monitoring to ensure that gases given off by the decaying garbage do not become a health risk or pollute the environment. The methane gas can be collected at a landfill and is often used as a source of energy.

Another landfill feature that helps to protect the environment is the use of an impervious clay layer and a synthetic plastic membrane at the landfill site. A geotextile cushion, crushed rock, another layer of cushion, and soil are placed on top on the plastic membrane before refuse is added. Sometimes a cushion is also placed below the plastic membrane. These features keep the potentially hazardous liquid, called leachate, which accumulates when rainwater leaches through the garbage, from contaminating groundwater.

Leachate can run off from the landfill and contaminate streams and other surface waters. If leachate from a landfill seeps down and reaches the water table, it can contaminate groundwater. With over half of all Americans dependent on groundwater for their drinking water, contaminated groundwater constitutes a significant problem. Therefore, landfill operators are required to install a leachate collection system to collect and remove the leachate that gathers at the base of the landfill. The groundwater and surrounding surface waters must be regularly monitored for contaminants from the landfill. (More information on leachate and its hazards to groundwater is provided in the "Background Information for the Teacher" in the 4–6 Module, Unit 4, Lesson 2. Also, see "Appendix B–IV, Landfill Issues.")

Every day dump trucks deliver tons of garbage and discarded materials to landfills. Throughout the day the garbage is compacted with heavy machines. A layer of soil is placed over the garbage to keep it from creating foul odors and to keep animals, including insects, from getting into the garbage and spreading it around. Landfill operators will sometimes use a substitute cover if soil is hard to find. This substitute material may be ground or chipped old tires, green waste, or special woven tarps made from plastic.

Once landfill sites have reached capacity, they must be capped (closed with layers of clay and

[2]"Estimated California Waste Tonnages and Diversion Rates." Information sheet. Sacramento: California Integrated Waste Management Board, November, 1998.

[3]Written communication from Joe Haworth, Information Officer, County Sanitation Districts of Los Angeles County, October 22, 1998.

soil) and monitored. Such sites are often landscaped and used for parks, golf courses, hiking and equestrian trails, and open spaces. Some problems have resulted from the buildup of explosive methane gas and the settling of buried trash. Engineers and scientists are working on ways to make these sites safe for people and wildlife.

The California Integrated Waste Management Board (CIWMB) is responsible for implementing the Integrated Waste Management Act (AB 939), which is a comprehensive set of laws, passed in 1989, designed to address California's solid waste problems and lessen the demand on natural resources. Students can help to reduce solid waste through reducing, reusing, recycling, and composting. For more information on waste management-related legislation, see "Appendix B–I, History of Waste Management."

The integrated waste management hierarchy promoted by the California Integrated Waste Management Board emphasizes the following priorities concerning products and packaging:

1. Reducing and reusing

2. Recycling and composting

3. Environmentally safe transformation (waste-to-energy) and environmentally safe land disposal (landfilling)

"Although there are not many waste-burning plants in California, there are two large waste-to-energy facilities in southern California. With the low price of electricity and the general opposition to burning things in California, there has been a deemphasis on waste-to-energy, but there are people whose communities use those plants—mainly the cities of Commerce and Long Beach."[5] For more information on waste-to-energy facilities, see "Appendix B–V, Incineration: Waste-to-Energy Facilities."

Understanding the role landfills play in managing our waste and their potential environmental impacts will enable us to use our natural resources in a more efficient manner.

The Ogden–Martin waste-to-energy facility receives four tons of garbage daily from the county of San Joaquin and the city of Modesto, which is deposited by 20-ton garbage trucks into the waste storage pit. The crane collects this garbage and feeds the two combustion units that generate 21.5 megawatts of electricity per hour. Photo courtesy of Ogden-Martin.

LESSON 3: Keeping Items Cycled

LESSON'S CONCEPTS

- Everything people make, use, and discard comes from natural resources.
- Most products made by people can be kept out of landfills and kept in a cycle through reusing and recycling.

PURPOSE

Students determine ways to extend the life cycle of various objects.

OVERVIEW

In this lesson students will:

- Classify objects they brought to class according to the category of natural resources from which the objects were made.
- Develop a list of questions to find out what natural resources were used and the steps that it took to make a particular object.
- Work in groups to do the necessary research to answer their list of questions about an object they select and the ways that object can be kept out of a landfill.
- Determine how reusing or recycling extends the "life cycle" of an object.
- Present to the class their reports on how to keep an object out of a landfill.

CORRELATIONS TO CALIFORNIA'S CONTENT STANDARDS AND FRAMEWORKS AND TO BENCHMARKS FOR SCIENCE LITERACY

- Students identify ways that the life cycle of certain objects can be extended (e.g., through reusing and recycling) to keep them out of landfills.
  - "Discarded products contribute to the problem of waste disposal. Sometimes it is possible to use the materials in them to make new products, but materials differ widely in the ease with which they can be recycled." (*Benchmarks for Science Literacy,* page 189)
  - "Many materials can be recycled and used again . . .." (*Benchmarks for Science Literacy,* page 119)
  - "Some materials can be used over again." (*Benchmarks for Science Literacy,* page 188)
- Students work together to answer questions about the steps that it took to make a particular item and the ways in which its life cycle can be extended.
  - "Sources of energy and materials differ in amounts, distribution, usefulness, and the time required for their formation. As a basis for understanding this concept, students know . . . (the) natural origin of the materials used to make common objects." (*Science Content Standards, Grades K–12*; Grade 6; Resources, Standard 6c)
- Students present their reports on how to keep an object out of a landfill and listen to presentations by other students.
  - "Students listen critically and respond appropriately to oral communication. They speak in a manner that guides the listener to understand important ideas by using proper phrasing, pitch, and modulation." *(English–Language Arts Content Standards for California Public Schools, Kindergarten Through Grade Twelve*, page 26)

SCIENTIFIC THINKING PROCESSES

observing, communicating, comparing, ordering, classifying, inferring

TIME

30 minutes to prepare for the lesson; 45 minutes for Part I; 60–90 minutes for the research and presentations

VOCABULARY

life cycle

PREPARATION

___ **1.** Read the "Background Information for the Teacher" at the end of this lesson.

___ **2.** Ask students to bring to class one object (made from one natural resource) that was going to be discarded. Have several objects available for those students who did not bring an object; for example, a plastic container or bag, paper bag, a cotton rag, and a piece of aluminum foil.

___ **3.** Make or have students create a sign for each the following categories of natural resources: plants, animals, minerals, fossil fuels.

___ **4.** Make transparencies and a copy of each of the following illustrations located at the end of this lesson:

- "Examples of Questions Concerning the Life Cycle of an Item"
- "Life Cycle of a Tree"
- "Papermaking: One Way or a Cycle?"
- "Paper Manufacturing"
- "Recycled Paper Manufacturing"
- "Aluminum Can Manufacturing"
- "Recycled Aluminum Manufacturing"
- "Glass Manufacturing"
- "Recycled Glass Manufacturing"
- "Steel Can Manufacturing"
- "Recycled Steel Can Manufacturing"
- "Plastic Manufacturing"
- "Recycled Plastic Manufacturing"

MATERIALS

___ Piece of butcher paper on which to record students' responses
___ Leather belt
___ A sign for each the following natural resources: plants, animals, minerals, and fossil fuels
___ One copy and one transparency of each of the illustrations listed in "Preparation" #4.

PRE-ACTIVITY QUESTIONS

A. Project the transparency of a "Life Cycle of a Tree." Ask students:

- What is a cycle? *Something that occurs over and over again.*
- What are some examples of life cycles? *Human, insect, bird.*
- What other cycles exist in nature? *Seasons, water cycle, soil cycle.*

B. Project the transparency of "Papermaking: One Way or a Cycle?" Ask students:

- How is this cycle different from the life cycle of a tree? *The life cycle of a tree goes on and on, whereas the papermaking cycle may not be a cycle but can stop after the item is used and then taken to a landfill.*
- How can we keep an object from ending up in a landfill? *Reuse it, give it to someone, recycle it.*
- If objects are sent to the landfill, do they become part of a cycle? *Usually not.*
- How can an object become part of a cycle? *If it is reused or recycled.*
- Why don't people keep more waste out of the landfill? *It is not convenient; they do not want their houses to get full of trash; they don't know why it is important to do so.*

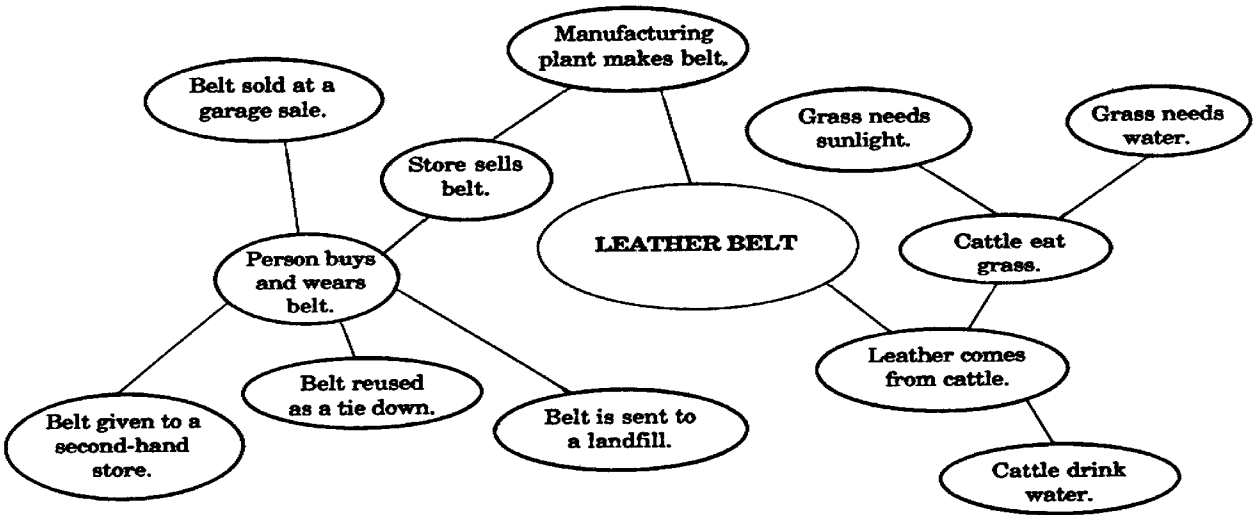
PROCEDURE

A. When all students have brought to class one object (made from one natural resource) that was going to be discarded, ask the students to show their objects and identify which category of natural resources each object came from.

B. In different places in the classroom, place the sign for four categories of natural resources from which most products are made (plants, animals, minerals, fossil fuels). Have students sort their objects into groups by a specific natural resource.

C. Place a leather belt by the "animal" sign. (This will probably be the smallest pile.) Tell students that the class will analyze the life cycle of this leather belt. This belt will be used as an example of questions that groups of students will answer concerning objects from this and other piles.

D. Develop with students a list of questions that should be answered to find out where the leather belt came from and what will happen to it after the person who bought it no longer wants it. Examples of questions are listed in "Examples of Questions and Answers Concerning the Life Cycle of a Leather Belt" at the end of this lesson.



1. Write these questions on the chalkboard or on a piece of butcher paper to post in the classroom.
2. Another way to do this is to develop a mind-map. This is done by placing the words "leather belt" in the middle of a large piece of butcher paper or on the chalkboard. Have students come up with different ideas about the life cycle of the belt and place these ideas in bubbles around the item. Each bubble can also have its own connections with its own set of bubbles.

E. Have students form groups based on the natural resource that was used to make the objects they brought. For example, have students who brought objects that are now in the plant pile form a group. There will be four groups: plants, animals, minerals, and fossil fuels.

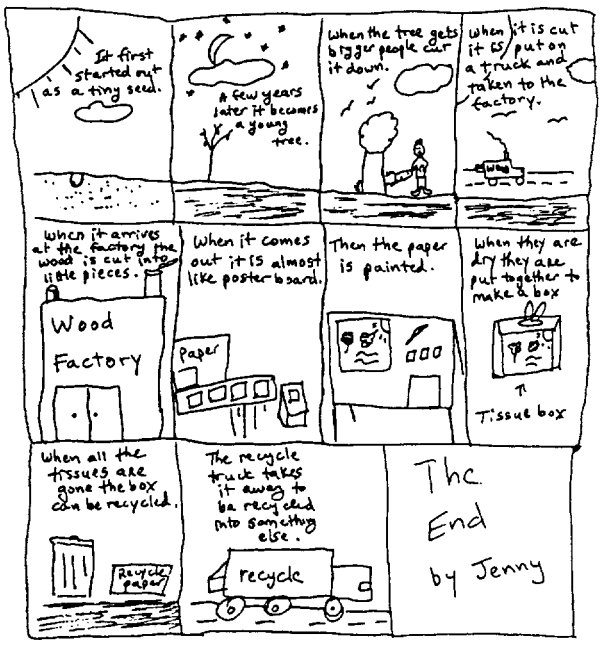
Note: If the groups are too large, split groups into two or more groups. Each group can select a different item to analyze.

F. Ask each group to select one item. Develop a set of questions to learn more about this item. (Examples of questions are listed in "Examples of Questions Concerning the Life Cycle of an Item" at the end of this lesson.) Have students within the group list and draw the life cycle of this item. They should:

- Consider all the steps that it took to make this item.
- Include a scene showing where the natural resource once was, how it was obtained by people, how it arrived at the place where it will be processed, and how it might have been processed.
- Describe how this item can remain in a cycle to conserve natural resources.
- Answer the questions that they developed or the questions in "Examples of Questions Concerning the Life Cycle of an Item."

G. Have groups present their answers. Students can identify the similarities and differences of each object's life cycle.

Homework Assignment: Ask students to select an object from home that is made from one natural resource. Ask them to draw a series of illustrations of what it took to make this object.



Submitted by Ed Malaret, fifth-grade teacher, Marguerite Hahn Elementary School, Cotati–Rohnert Park Unified School District.

Then they will need to describe where this object will go once it is no longer useful and how its life cycle can be extended.

H. Ask students to share their homework assignments in groups.

DISCUSSION/QUESTIONS

A. Discuss with students:

- What are ways that we can extend the life cycle of objects? *Recycle them, reuse them, or give them to someone else to use.*
- Why is it important to keep natural resources from going to landfills? *To keep the landfills from filling up rapidly; to save natural resources so less will need to be acquired from the natural environment.*
- What can be done to keep an old T-shirt that is no longer wanted by its owner out of a landfill? *Give it to someone else; use it as a dust rag; make a section of a quilt out of it; weave it into a throw rug.* Tell students that if the T-shirt is made from cotton, it can also be composted to enrich soil to grow plants.

APPLICATION

A. Separate the class into five groups. Give the following copies and corresponding transparencies to each group:

Group 1: "Paper Manufacturing" and "Recycled Paper Manufacturing."

Group 2: "Aluminum Can Manufacturing" and "Recycled Aluminum Manufacturing."

Group 3: "Glass Manufacturing" and "Recycled Glass Manufacturing."

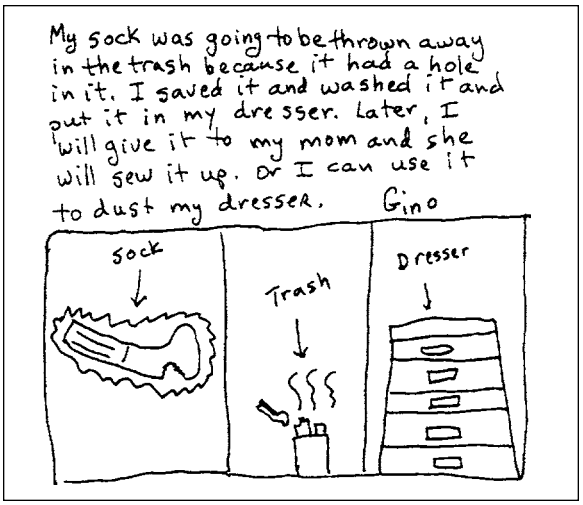
Group 4: "Steel Can Manufacturing" and "Recycled Steel Can Manufacturing."

Group 5: "Plastic Manufacturing" and "Recycled Plastic Manufacturing."

B. Ask groups to prepare a short presentation to show the class the differences between manufacturing items from raw materials compared to using recycled materials. Encourage students to use the transparencies during their presentations. Each student must participate in some part of the presentation.

C. Discuss with the class how recycling conserves natural resources.

Homework Assignment: Have students select an item that was being discarded at home. Ask them to describe what it will take to keep this item in the loop or to extend the life cycle of this item. They should also describe why this item might not be kept in a cycle. Tell students that they should be prepared to discuss their items within a group the following day.



Submitted by Ed Malaret, fifth-grade teacher, Marguerite Hahn Elementary School, Cotati–Rohnert Park Unified School District.

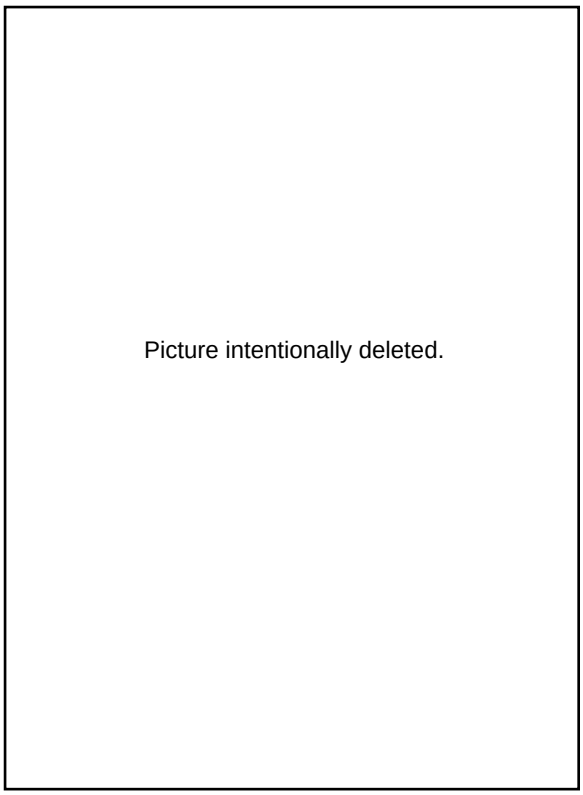
D. The following day, ask students to meet in groups and share their homework assignments. Students should be aware that many objects can be reused or recycled into new products. They should also understand that some items cannot be reused or recycled because they are designed to be used one time (e.g., a toothpick, packaging from some restaurants, paper napkin).

Project Idea: Have students bring in clean pieces of old clothes and braid a class throw rug.

EXTENSIONS

A. With the whole class, write or recite and record a story of how an item came to be and how its life cycle can be extended. One way to do this is described below:

- Select an item.
- Have one student in the class begin the story.
- Have another student add to the story.
- The goal is to continue the story to allow everyone in the class to add to the story.
- The ending of the story should indicate that the item will continue to be used and not end up in a landfill.



Two students from Valley Oak Elementary School braided pieces of cloth to make a throw rug.

B. Have students work in groups and look at objects made from more than one natural resource. For example:

- Roller-blade (metal, leather, cotton)
- Raincoat (plastic, metal, cotton)
- Bed (metal, wood)
- Desk (metal, wood, plastic)

Ask students to draw the item and label each section with the natural resource from which it came.

RESOURCES

Videos

Recycle It! Northbrook, Ill.: Film Ideas, Inc., 1993 (16 minutes).

A music video featuring the World Patrol Kids who explain how aluminum, plastic, paper, and glass are recycled at industrial plants.

Recycling. Earth Science series. Northbrook, Ill.: Film Ideas, Inc., 1994 (20 minutes).

Shows how products get to market through the mining, milling, and refining of raw materials. Explains why recycling and reprocessing waste are important.

Recycling: The Endless Circle. Washington, D.C.: National Geographic, 1992 (25 minutes).

Explains how recycling returns used materials (e.g., paper, aluminum, and plastic) to make new products, therefore reducing waste.

Books

Brooks, Felicity. *How Things Are Made*. Finding Out About series. Tulsa, Okla.: EDC Publishing, 1989.

Explains from what natural resources things are made. Contains illustrations and descriptions of how some items are made. These include leather shoes, clay pottery, clothing, paper, glass bottles, cans, plastic blocks, and soap.

Jones, George. *My First Book of How Things Are Made*. New York: Scholastic, Inc., 1995.

Explains how crayons, peanut butter, grape jelly, footballs, orange juice, blue jeans, guitars, and books are made. This book can be used to show students ways people make products from plants.

Websites

See "Appendix F–IV, Natural Resources websites."

EXAMPLES OF QUESTIONS AND ANSWERS CONCERNING THE LIFE CYCLE OF A LEATHER BELT

The following example outlines the life cycle of a leather belt:

1. From what category of natural resources was this item made? *Animal.*
2. From what type of animal was this item made? *Cow.*
3. Was it a living natural resource or a nonliving one? *Living.*
4. If living, what natural resources did this living thing use when it was alive? *Air, water, plants, soil; the plants the cow ate used sunlight and minerals as well as air and water.*
5. How did a part of it become a belt? *It was killed for food, and part of its hide was used to make the belt.*
6. What natural resources were used for the transportation of the cow and its hide? *Fossil fuels.*
7. What natural resources were needed to make the belt? *The animal, water, fossil fuels.*
8. Might any pollution be caused during the manufacturing process? If so, what natural resources might be polluted? *Maybe water and air.*
9. What happens to the belt after it is made? *It goes to a wholesaler and then to a department store.*
10. Who bought it? *A person.*
11. Why was it bought? *Because the person liked it or needed a belt.*
12. How will it be used by the person who bought it? *As a belt, but possibly as a dog leash, or to secure something on the person's bicycle.*
13. How did the person get to and from the store where the belt was bought and what natural resources were used? *By car that uses fossil fuels and all the natural resources used to make that car.*
14. How long will this person probably keep the belt? *One or two years; until the person gains weight; until the person doesn't want it any longer; until the belt breaks.*
15. What will happen to the belt after the person no longer wants it? *It will go into the trash can and then to the landfill; if it is still in good shape, it could be given to someone, taken to a secondhand store, or sold at a garage sale.*
16. What could the person have done to make sure that the belt didn't break? *The person could make sure that a high quality belt was purchased, that the type of belt bought will always be in style; the person could make sure that he or she does not gain too much weight.*
17. If the belt is headed to the landfill, what can be done to keep it from going to the landfill? *Reuse it or give it away.*
18. If it goes to the landfill anyway, what natural resources were wasted in the making of this item, since it is now being thrown into a landfill? *All the natural resources used by the cow, the fossil fuels in transportation, and the resources used in making the belt.*
19. Can the belt be recycled? *Probably not.*
20. Can the belt be reused? *It could be used for another purpose, such as a tie down.*

Transparency or Student's Page

EXAMPLES OF QUESTIONS CONCERNING THE LIFE CYCLE OF AN ITEM

1. From what categories of natural resources was this item made?

2. Was it a living natural resource or a nonliving one?

   a. If living, what natural resources did this living thing use when it was alive?

   b. How did it get to the manufacturing plant where the item was made? What natural resources were used for its transportation?

   c. What were the steps that led from the living natural resource to the item?

3. If not living, how was this item made? What natural resources were used for its transportation?

4. What other natural resources were needed to make the item?

5. Might any pollution be caused during the manufacturing process? If so, what natural resources might be polluted?

6. What happened to the item after it was made?

7. Who bought it?

8. Why was it bought?

9. How will it be used by the person who bought it?

10. How did the person get to and from the store where the item was bought and what natural resources were used for that purpose?

11. How long will this person probably keep the item?

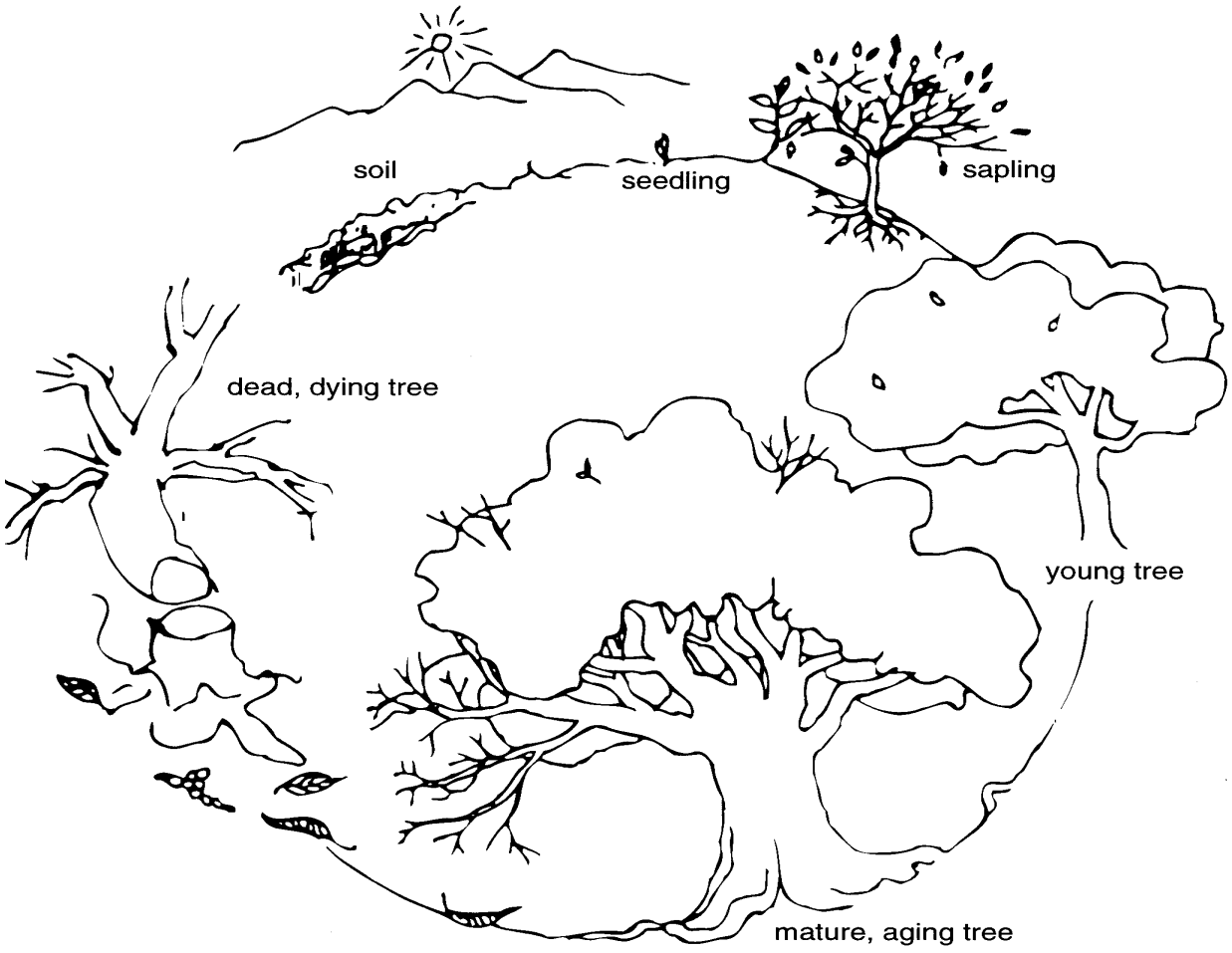
12. What will happen to this item after the person no longer wants it?

13. If the item is headed to a landfill, what can be done to keep it from going to the landfill?

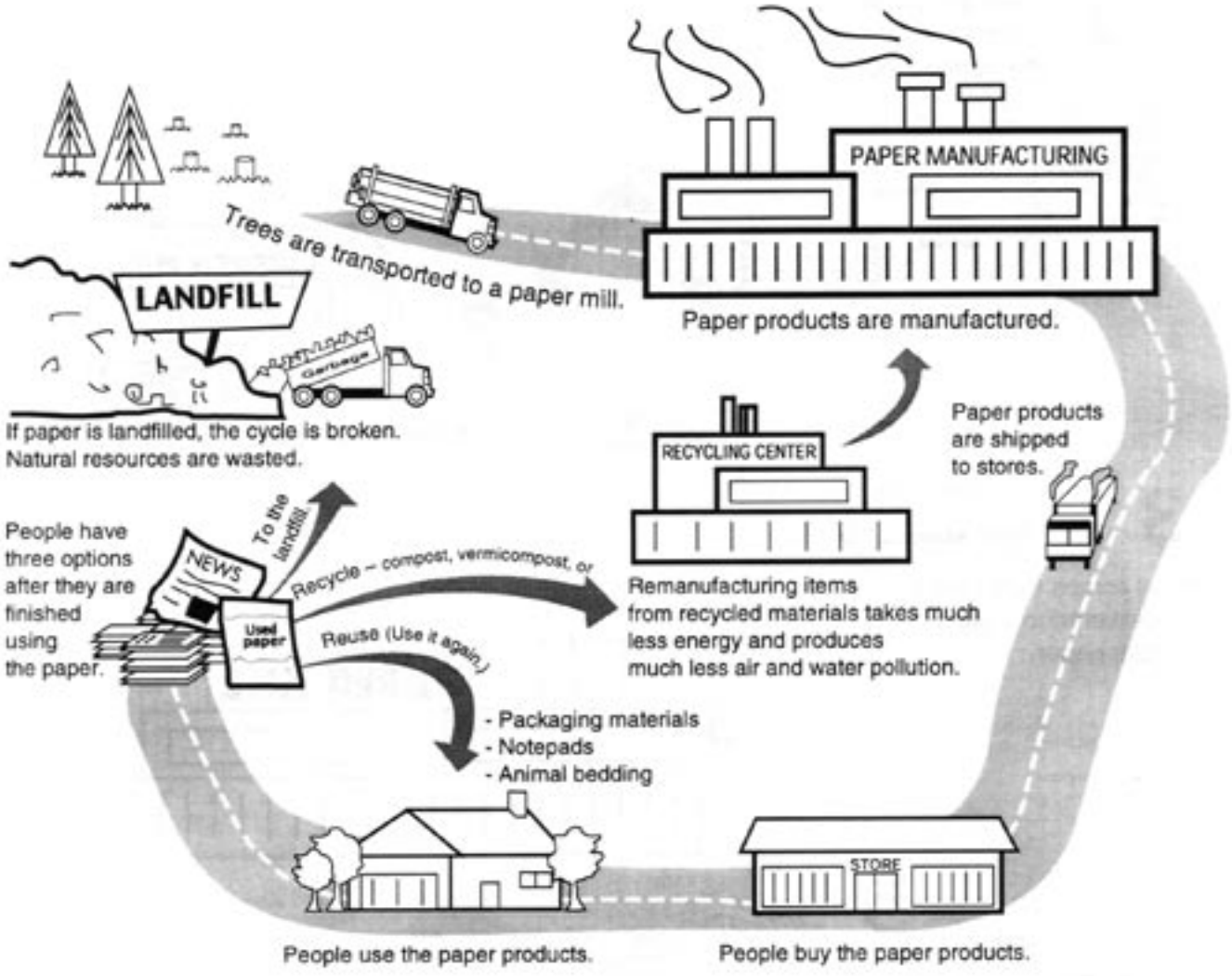
14. If the item is going to a landfill anyway, what natural resources would have been wasted in the making of this item?

Transparency and Student's Page

LIFE CYCLE OF A TREE



PAPERMAKING: ONE WAY OR A CYCLE?



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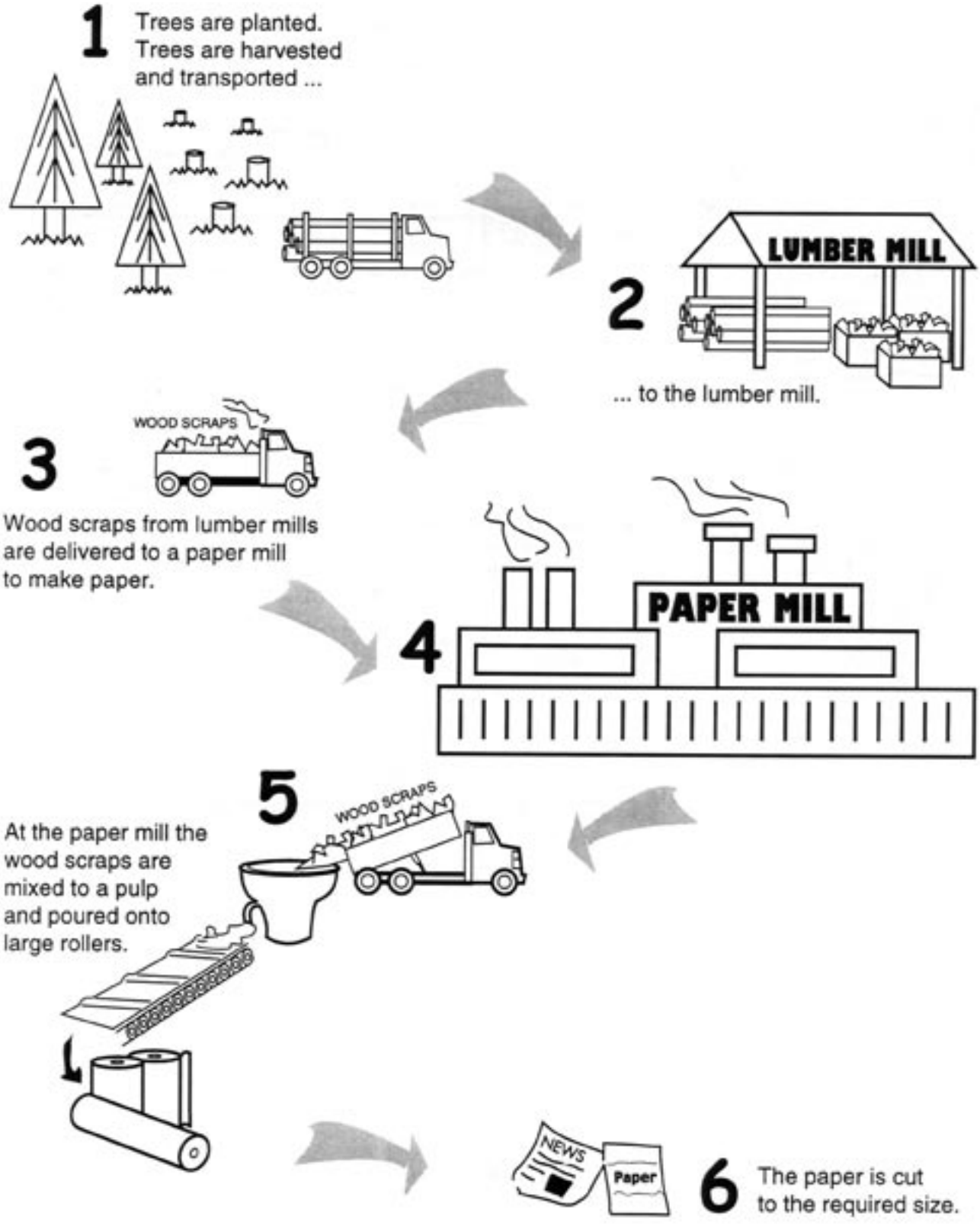
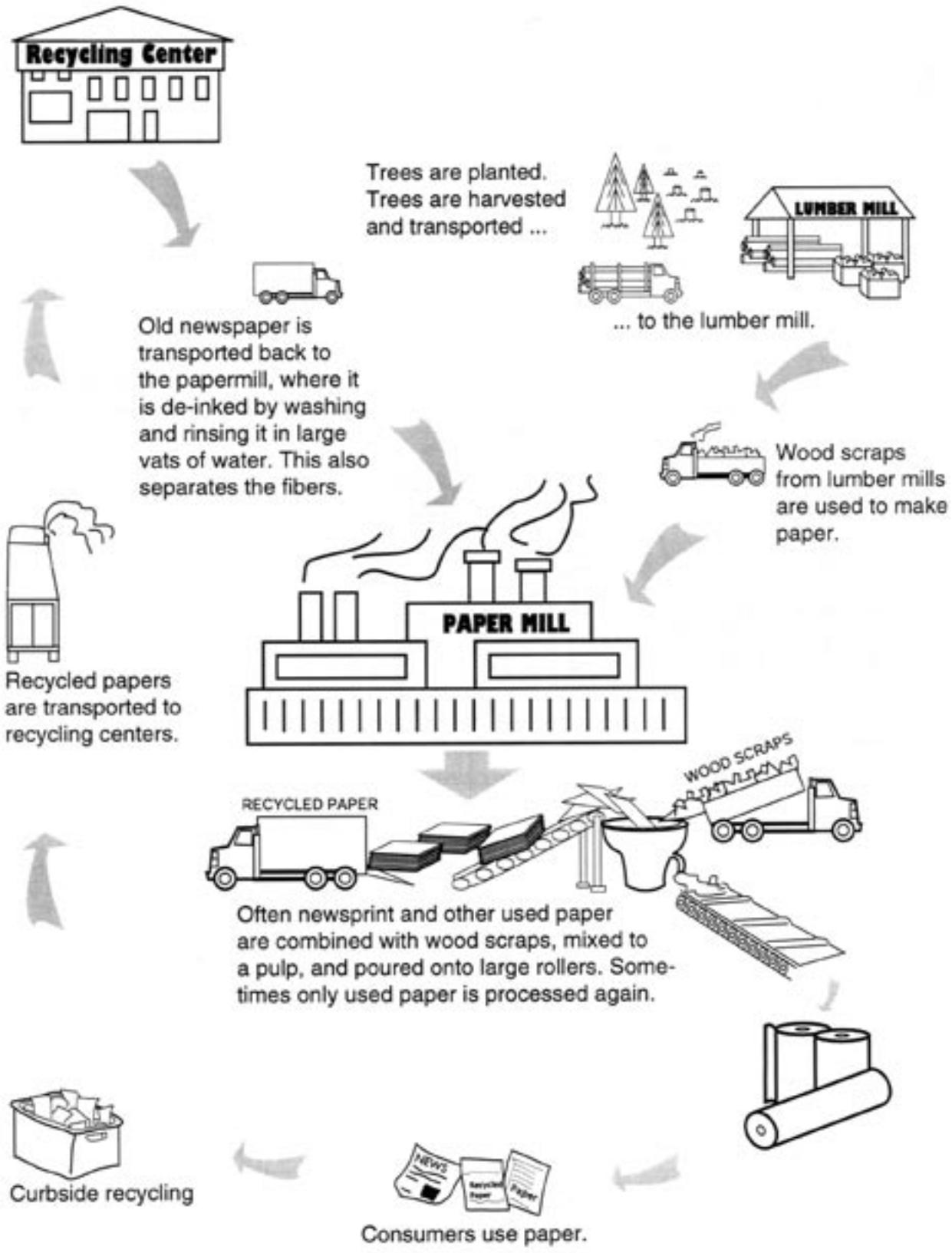
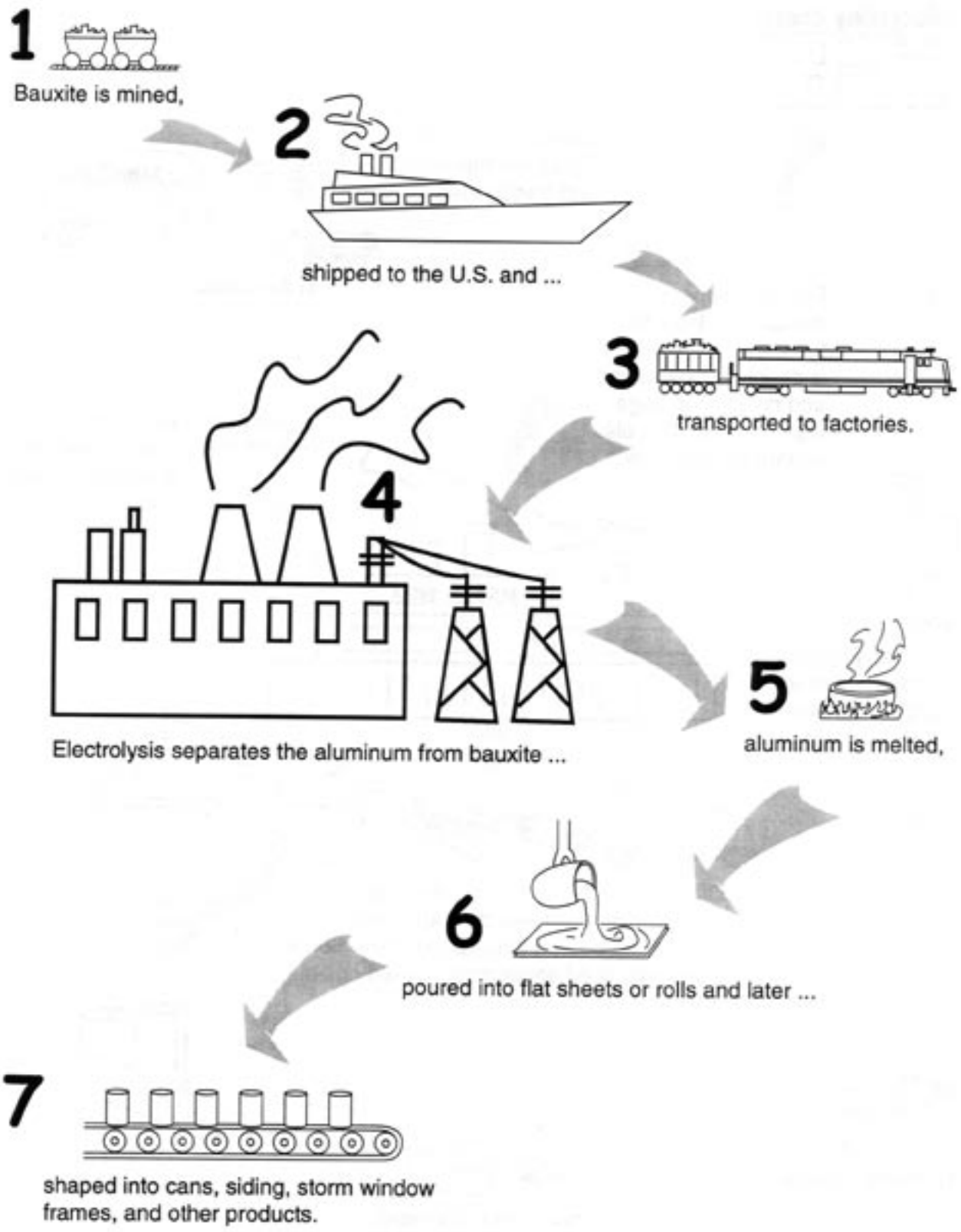
PAPER MANUFACTURING



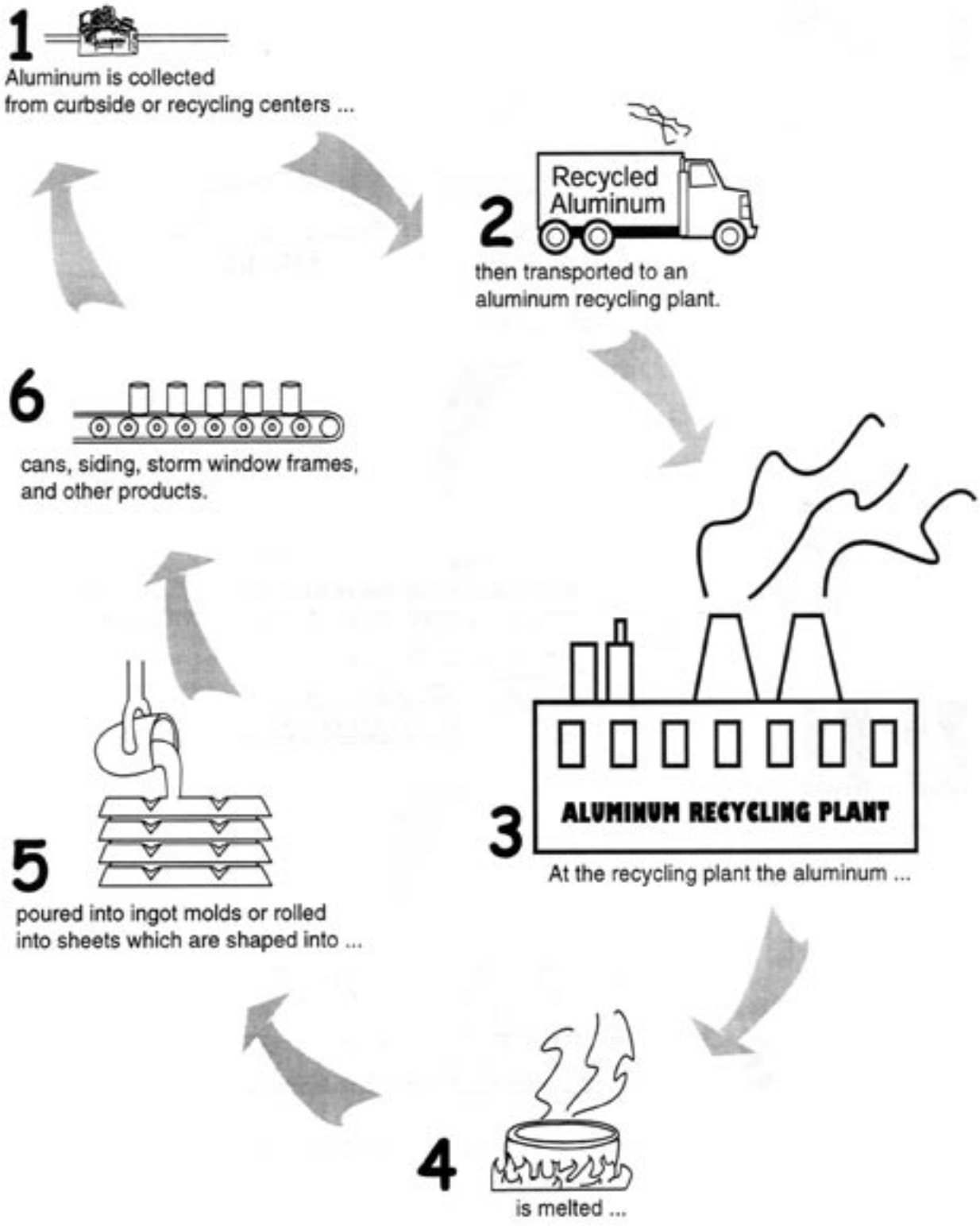
RECYCLED PAPER MANUFACTURING



ALUMINUM CAN MANUFACTURING

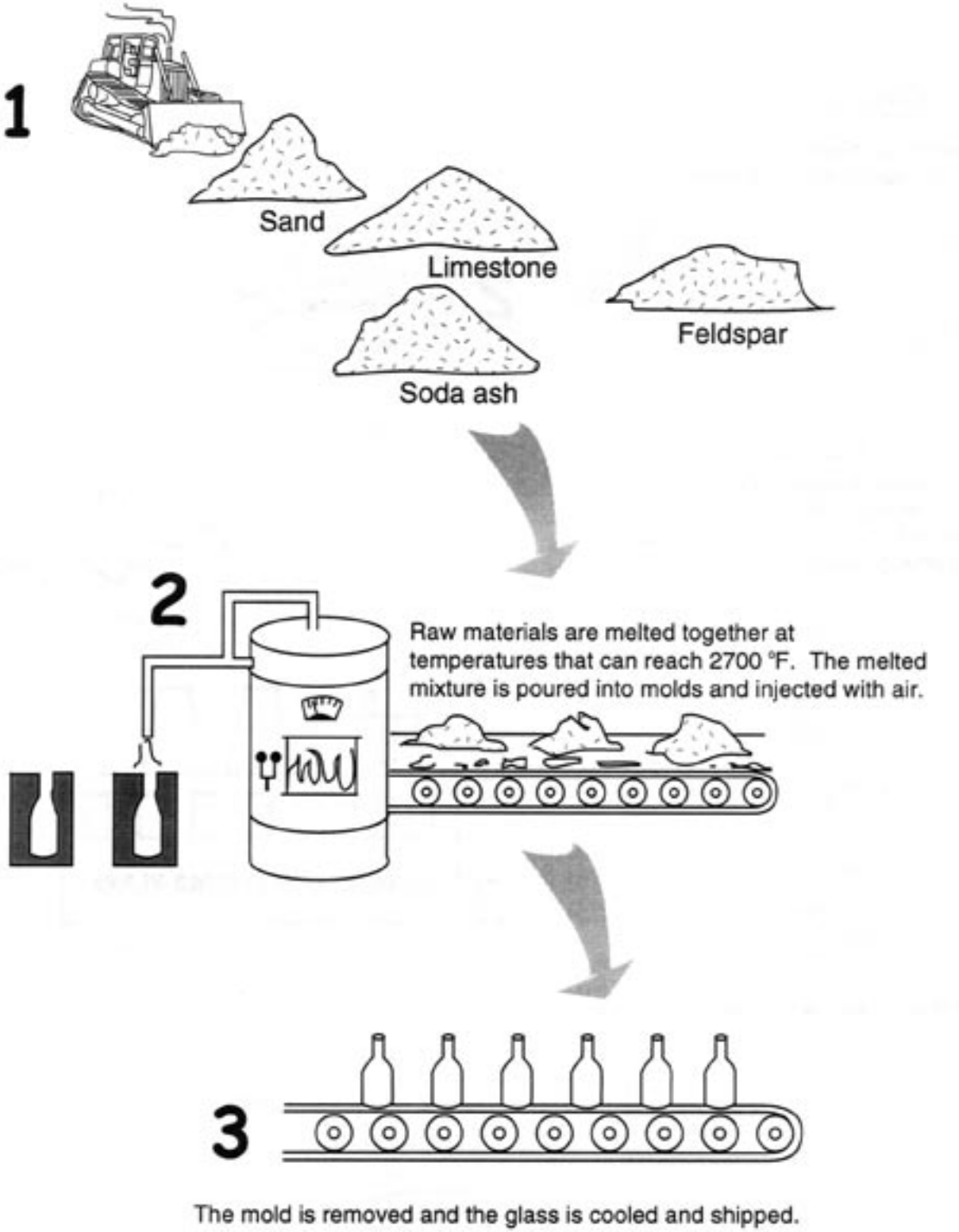


RECYCLED ALUMINUM MANUFACTURING

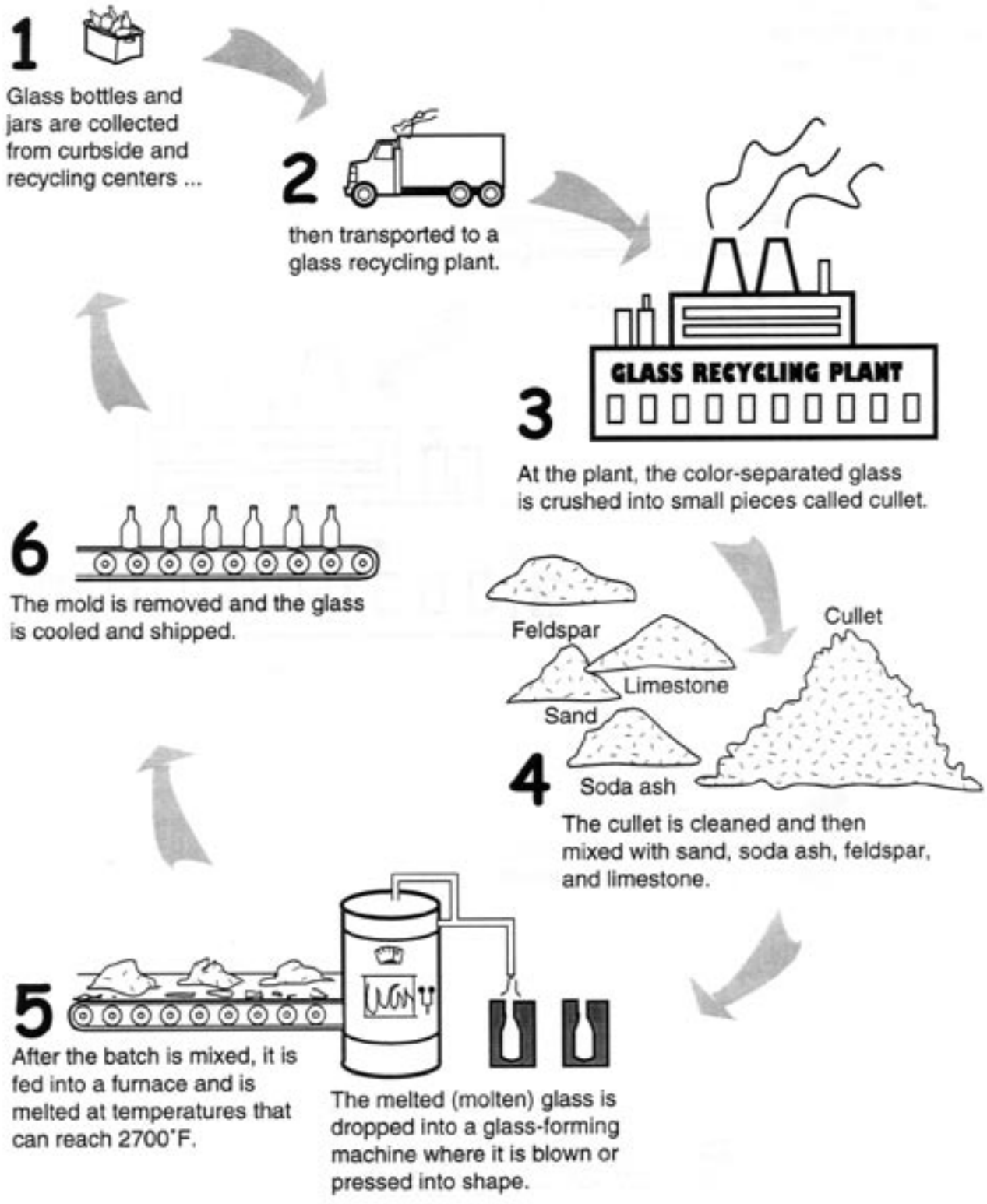


Transparency and Student's Page

GLASS MANUFACTURING



RECYCLED GLASS MANUFACTURING



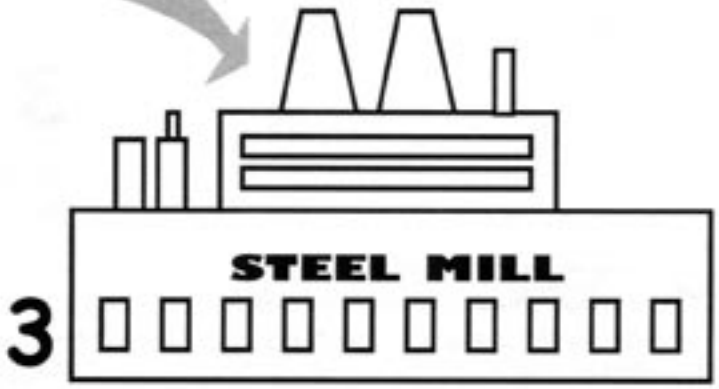
Transparency and Student's Page

STEEL CAN MANUFACTURING

1 

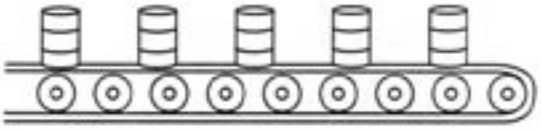
Iron ore and other minerals are dug from mines and ...

2 transported ...



3 to steel mills.

4 The iron ore minerals are heated in large vats and poured onto sheets.



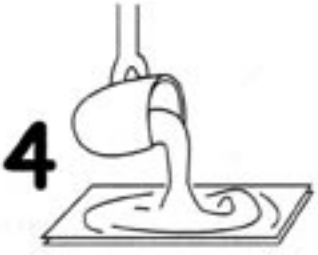
5 The steel is coated with tin and shaped into cans.

RECYCLED STEEL CAN MANUFACTURING

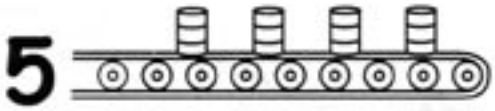
1 Empty steel cans are collected from curbside or recycling centers.

2 After the steel cans and other steel products are collected, they are transported ...

3 to steel mills.



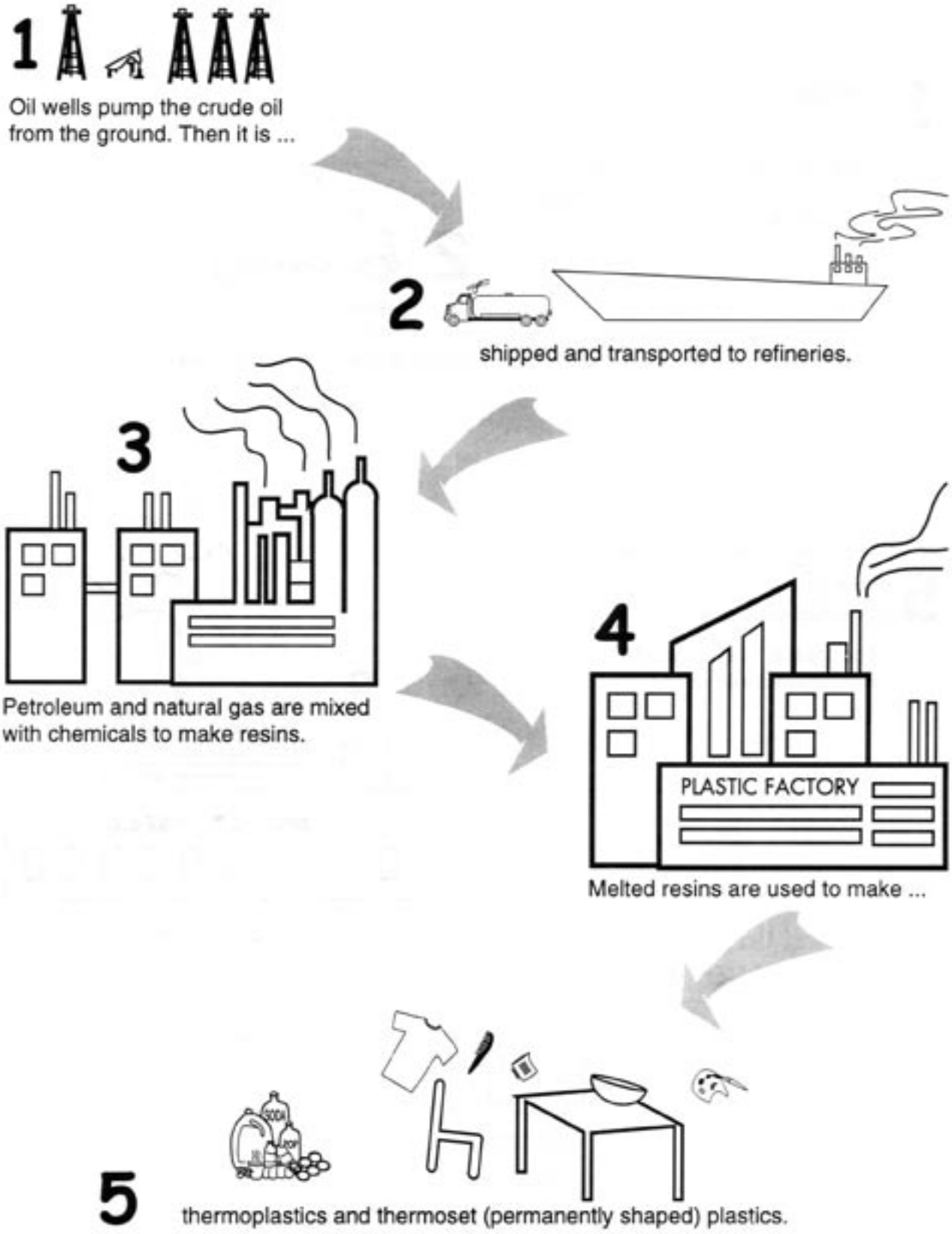
4 The steel is heated in large vats and poured onto sheets



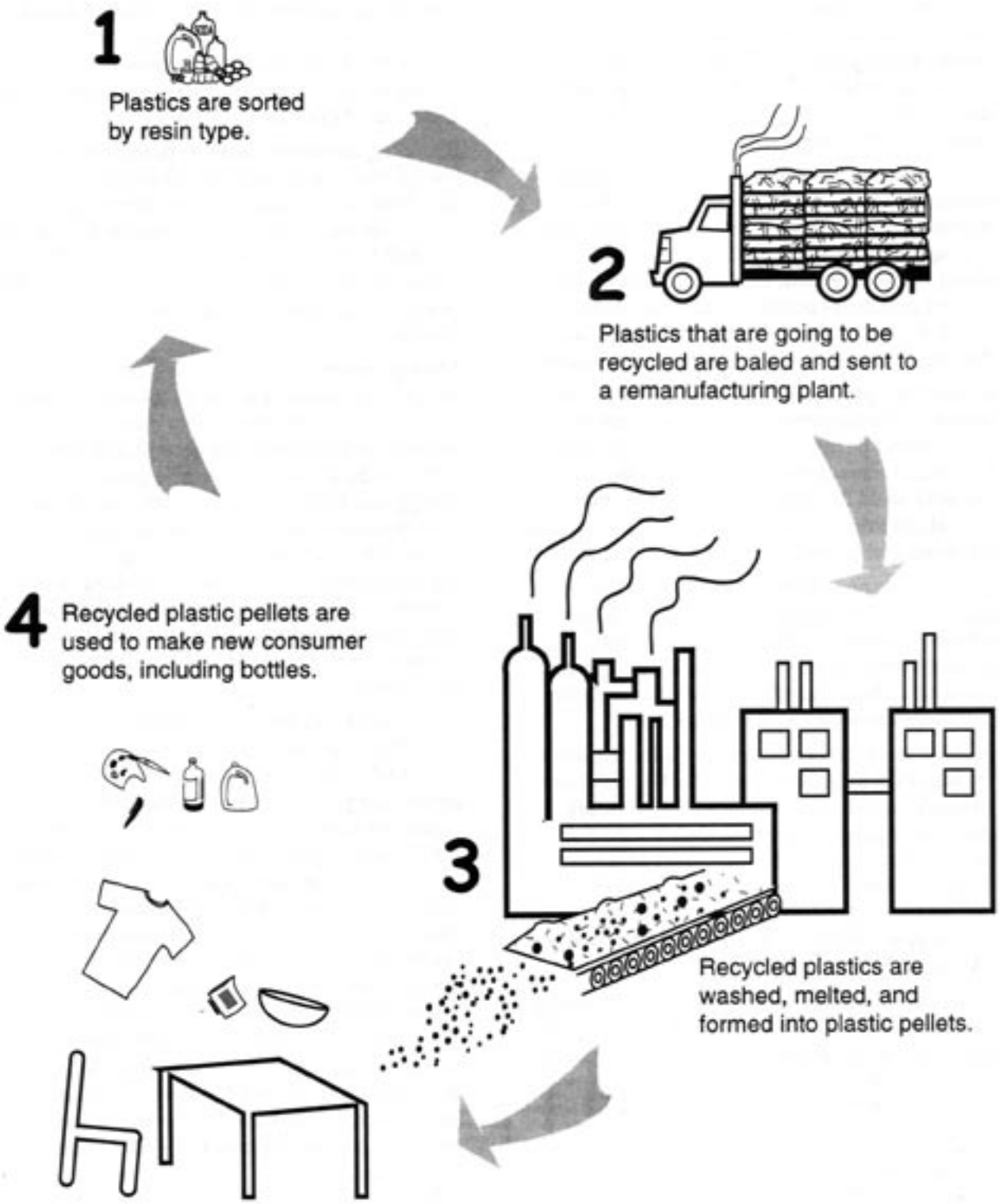
5 The steel is coated with tin and shaped into cans.

Transparency and Student's Page

PLASTIC MANUFACTURING



RECYCLED PLASTIC MANUFACTURING



BACKGROUND INFORMATION FOR THE TEACHER

Natural resources may undergo many processes (e.g., quarrying limestone, refining oil) between extraction and use. These steps often impact the environment in negative ways. To conserve natural resources and reduce the impact on the environment when extracting raw materials, communities need to reuse and recycle some human-made products. For example, used glass bottles can be washed and reused, or the used glass bottles can be crushed and melted and reformed to make new glass.

A life cycle is a series of stages through which something (e.g., an individual living thing or a manufactured product) passes during its lifetime. Through reusing and recycling, the life cycle of an object can be extended. This action conserves the natural resources (including energy sources) which would be used to replace this object, and the action also keeps the object out of the landfill.

If half of the paper used in the world today were recycled, three-quarters of the demand for new paper would be met. As a result, approximately ten million acres of forest destined for the paper industry could be conserved. At present, however, about three-quarters of used paper resources are wasted when they are placed in a landfill.

According to one estimate, when new paper is made from waste paper instead of trees, a large amount of water is conserved and 30 to 64 percent less energy is used. Also, 74 to 95 percent fewer air pollutants and 35 percent fewer water pollutants are added to the environment.[1]

Reusing and recycling paper also helps to extend the life of landfills. Nearly one third of the waste stream by weight and over half by volume are made up of paper. Paper that has been used on one side can be reused by using the blank side for notepaper. Recycling one ton of used paper can save an average of two to three cubic yards of landfill space. For more information on paper, see "Appendix C–VII, Paper."

Using cullet (crushed recycled glass) saves energy because it melts at a lower temperature. For each 10 percent of cullet used, the furnace temperature can be lowered 10 degrees, and the batch in most cases can consist of up to 83 percent recycled glass. Recently, several new glass manufacturing systems were developed that use nothing but glass cullet. Using one ton of recycled glass will save 1.2 tons of raw materials. According to one estimate, by using 50 percent recycled glass in manufacturing new glass, the manufacturer can cut water consumption in half; and air emissions, 14 percent. In addition, mining wastes can be decreased by 79 percent. For more information on glass, see "Appendix C–IV, Glass."

Recycling aluminum saves 95 percent of the energy required to produce it from raw materials (i.e., mine and process bauxite). Recycling an aluminum can saves the equivalent in fuel of that can half-filled with gasoline. In addition, 95 percent of the air pollution is eliminated, and 100 percent of the solid waste is diverted from landfills.[2]

Mining iron ore and producing steel can pollute the environment and is energy-intensive. Using scrap instead of raw iron ore to make new steel reduces air pollution by 86 percent and water pollution by 76 percent; saves 74 percent of the energy and 40 percent of the water that would have been used with raw materials; and reduces the need for raw materials by 90 percent. During the last ten years, improved steelmaking technologies, which yield less scrap, have increased the demand for purchased scrap by more than 50 percent. For more information see "Appendix C–III, Ferrous Metals."

Plastics are made from fossil fuels (oil and natural gas). Therefore, using recycled plastics conserves fossil fuels. The success of recycling plastics depends in part on the proper identification and separation of plastics. Polyethelene terephthalate (PETE) soda bottles and high-density polyethylene (HDPE) milk, juice, laundry detergent, and water containers are most often recycled, because they are made from one kind of plastic and are easily identifiable. HDPE jugs are shredded and remanufactured to make products such as plastic lumber. PETE soda bottles are shredded into fibers and woven back into threads to make clothing or are used to stuff sleeping bags, quilts, and parkas. (See the 4–6 Module, Unit 2, Lesson 7 for additional information and activities on plastics. Also, see "Appendix C–VIII.")

[1] G. Tyler Miller, Jr., Environmental Science: Working with the Earth (Fifth edition). Belmont, Calif.: Wadsworth Publishing Company, 1995, p. 346.

[2] *Ibid.,* p. 345.

LESSON 4: Renewable and Nonrenewable Natural Resources

LESSON'S CONCEPTS

- Renewable natural resources are those which can be replaced naturally or through human-assisted actions within a relatively short amount of time (e.g., within a human lifetime). Examples of renewable natural resources are plants, animals, water, air, and some energy resources, such as sunlight.
- Nonrenewable natural resources are those available in limited amounts and take millions of years to be replaced; therefore, people can rely only on those deposits already in existence. Examples of nonrenewable natural resources are most minerals (e.g., iron ore) and some energy resources (e.g., fossil fuels).

PURPOSE

Students learn the difference between renewable and nonrenewable natural resources. They also learn that people in the United States use a large number of nonrenewable resources which are acquired from other countries.

In Part II, older students (grades five and six), will participate in a simulation activity that focuses on the scarcity of some mineral resources.

OVERVIEW

In this lesson students will:

- Determine which natural resources are considered renewable and which are considered nonrenewable.
- Classify items found in the outdoors and in the classroom as being made from renewable natural resources, nonrenewable natural resources, or both types of resources.
- Write a pledge to avoid wasting one specific material at school or at home.
- Design posters or a bulletin board featuring pictures of renewable and nonrenewable natural resources.

For Part I younger students (grade four) will:

- Identify the location of some mineral reserves, such as bauxite, iron ore, and tin.
- Read a chart to determine how long certain mineral resources are likely to last.

For Part II, older students (grades five and six) will:

- Search the classroom for various colored beads that represent finite mineral resources.
- Compare the numbers acquired in a simulation game to the actual global reserve base of specific mineral resources.
- Analyze charts and graphs concerning mineral resources.
- Arrange in order some mineral resources that are most abundant to those that are less abundant.

CORRELATIONS TO CALIFORNIA'S CONTENT STANDARDS AND FRAMEWORKS

- Students compare renewable to nonrenewable natural resources. They classify items outdoors and in the classroom as being made from renewable or nonrenewable natural resources or from both types of resources.
  - "All resources used by humans, including fuels, metals, and building materials, ultimately come from the Earth. Many of these resources are not in endless supply. They have taken many thousands and millions of years to develop and accumulate. They must be used with care, conserved, and recycled." (*Science Framework*, page 97)

- "Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept . . . students will: classify objects . . . based on appropriate criteria . . .." (*Science Content Standards, Grades K–12*; Grade 5; Investigation and Experimentation, Standard 5a)
- "Students know . . . different natural energy and material resources, including air, soil, rocks, minerals, petroleum, fresh water, wildlife, and forests, and classify them as renewable or nonrenewable . . .." (*Science Content Standards, Grades K–12*; Grade 6; Resources, Standard 6b)

• Students work together to gather colored beads and identify what mineral each color of bead represents.
- "To participate effectively in society, students need to: Develop personal skills . . . group interaction skills (and) . . . social and political participation skills." "*History–Social Science Framework*, page 24)

• Students analyze charts and graphs.
- Students "interpret one- and two-variable data graphs to answer questions about a situation." *(Mathematics Content Standards for California Public Schools, Kindergarten Through Grade Twelve*, page 18)

SCIENTIFIC THINKING PROCESSES

observing, communicating, comparing, ordering, classifying, relating

TIME

45 minutes to prepare for the lesson; 60–90 minutes to implement the lesson

VOCABULARY

ecosystem, nonrenewable natural resources, renewable natural resources

PREPARATION

___ **1.** Read the "Background Information for the Teacher" at the end of this lesson.

___ **2.** Make a transparency of "Some of the Earth's Natural Resources" (page 299).

For Younger Students (Grade Four)

For "Part I, Analyzing a Chart"

___ Make a transparency of "Life Expectancies and Main Consumers of Some Nonrenewable Natural Resources" (page 300).

For Older Students (Grades Five and Six)

For "Part II, Simulating the Scarcity of Some Mineral Resources"

___ **1.** Gather beads of different colors and coins to represent mineral resources (see the numbers and colors listed on "A Look at What's Left"). An option to using beads and coins is to use cutout circles from construction paper.

___ **2.** Hide beads and coins throughout the classroom. (Make sure that some of the beads are well hidden, so they will not be found immediately.)

___ **3.** Make transparencies of "A Look at What's Left" (page 301); "Depletion Time for Nonrenewable Resources" (page 302); "Life Expectancies and Main Consumers of Some Nonrenewable Natural Resources" (page 300); and "A World Map" (page 303).

___ **4.** Make copies for each group of "A Look at What's Left," "Life Expectancies and Main Consumers of Some Nonrenewable Natural Resources," and "A World Map."

MATERIALS

For "Pre-Activity Questions"

___ The transparency, "Some of the Earth's Natural Resources"

For Younger Students (Grade Four)

For "Part I, Analyzing a Chart"

___ Iron nail, lead fishing weight, aluminum can, and a tin can
___ Large map of the world
___ A transparency of "Life Expectancies and Main Consumers of Some Nonrenewable Natural Resources"

For Older Students (Grades Five and Six)

For "Part II, Simulating the Scarcity of Some Mineral Resources"

___ Transparencies of each of the following: "A Look at What's Left," "Depletion Time for Nonrenewable Resources," "Life Expectancies and Main Consumers of Some Nonrenewable Natural Resources," and "A World Map"

___ Charts titled, "A Look at What's Left," "Depletion Time for Nonrenewable Resources," and "Life Expectancies and Main Consumers of Some Nonrenewable Natural Resources," one for each group of students

___ Colored beads and coins in numbers required (See "A Look at What's Left.")

___ "A World Map" handout for each group of students

___ Large map of the world

PRE-ACTIVITY QUESTIONS

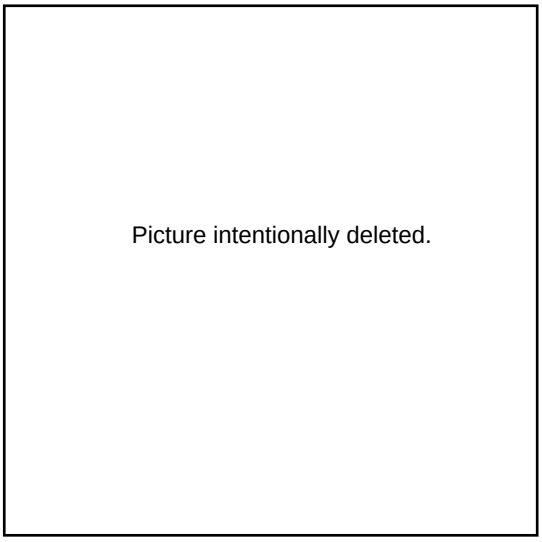
A. Ask students to identify for you the categories of natural resources, as you list them on the chalkboard: plants, animals, minerals, energy sources (e.g., sunlight, fossil fuels), soil, water, and air.

B. Tell students that some natural resources are considered to be renewable. What do they think *renewable* means? *They can renew themselves; they are available forever.* Write down their answers on butcher paper or chalkboard and review them at the end of the lesson. Ask students to give examples of renewable resources.

- Explain to students that scientists consider natural resources to be renewable if they are replaced naturally or through human-assisted actions within a relatively short amount of time, such as a human lifetime. For example, plants, such as trees, can be replanted indefinitely as long as the trees are selectively cut, allowing a certain number of mature trees to remain, and the soil in which these trees grow are protected from erosion. Proper management of the forest to ensure diversity and a healthy, well-functioning ecosystem is also important.
- Ask students to identify other renewable natural resources and why they think these resources are renewable. *Animals, because they can reproduce and have young; water, because the water cycle keeps recycling water; air, because plants and animals recycle the air; sunlight, because the sun is always there.*
- What could people do to make these renewable natural resources less renewable? *They could cause an animal species to become extinct. They could harvest the trees in a forest faster than the time it takes for more trees to grow and not plant any trees to replace the ones they harvested. They could pollute the water faster than the water cycle can clean it. They can pollute air in one area faster than the winds could blow it away.*

C. Ask students to explain what *nonrenewable* natural resources might mean and to give examples of nonrenewable natural resources. (These would be natural resources available in limited amounts.) *Fossil fuels (e.g., coal, oil, natural gas) and many minerals (e.g., iron, gold, bauxite).* Write students' answers on butcher paper or chalkboard. Students will discuss these answers at the end of this lesson. Explain to students that fossil fuels are considered to be nonrenewable natural resources because they take millions of years to form. Most minerals are also nonrenewable natural resources. Although they are continually being formed by geologic processes, the rate is so slow that human beings can rely only on those deposits already in existence.

D. Lead students outside and ask them to identify objects made from renewable and nonrenewable natural resources (or both).



Students from Valley Oak Elementary School identify objects made from renewable and nonrenewable natural resources.

E. Back in the classroom, project the transparency of "Some of the Earth's Natural Resources." Ask students to describe what the illustrations on the transparency are showing.

PROCEDURE

Note: Do "Part I" with younger students (grade four) and "Part II" with older students (grades five and six).

For Younger Students (Grade Four)

Part I, Analyzing a Chart

A. Show students an iron nail, lead fishing weight, aluminum can, and a tin can. Tell students that these represent mineral resources. In this lesson they will learn more about where some mineral resources come from and what country uses the largest amount of these resources.

B. Display a map of the world for students to refer to in part "C."

C. Project on an overhead projector the "Life Expectancies and Main Consumers of Some Nonrenewable Natural Resources." Explain that the natural resources used to manufacture many products are nonrenewable, are in limited supply, and are not found in the United States. Conduct a whole class discussion addressing the questions listed below. You might need to ask additional questions to lead students to specific answers.

- Why are projected rates of use greater than current rates of use? *It is projected that more people will use more natural resources. Increased population increases demand.*
- If we use mineral resources at projected rates, will we use them up faster or slower than if we used them at the current level? *Faster.*
- How will an increase in human population affect the rate of use of mineral resources? *The use of mineral resources will increase.*
- What mineral resources are not found in the United States? *Bauxite (from which aluminum is made) and tin.*
- What country(ies) or area(s) has (have) the greatest overall reserves of these minerals? *Australia, China, and Indonesia.* (Have students find these countries on the large map of the world.)
- How could dependence on other countries for mineral resources become a problem? *The people in the country can decide to stop selling the resources to the U.S.*
- How can we as individuals help stop the depletion of nonrenewable resources? (List the students' ideas on the chalkboard or on an overhead transparency and save for later discussion.)
- Ask students to answer questions "A" and "B" on the transparency. Discuss their answers.
- What did we learn from this chart? *The people in the United States use a lot of mineral resources; many of these mineral resources come from other countries.*

Note: Go to the "Discussion/Questions" section.

For Older Students (Grades Five and Six)

Part II, Simulating the Scarcity of Some Mineral Resources

Note: Make sure that you have hidden the beads and coins throughout the classroom when students were not present.

A. Divide students into teams (which could represent countries).

1. Give teams timed intervals of two minutes and one minute to explore for mineral resources. (The teams will search for two minutes, record their findings, and then search again for one minute and compare their findings with those during the two-minute search.)

2. After the exploration is concluded, provide a copy of "A Look at What's Left" to each group.

- Ask students to separate and identify the mineral represented by each color of bead or coin.
- Have them arrange the mineral resources in order from the largest amount of one resource to the least amount. They should record the numbers in their journals.
- If needed, project the transparency of "A Look at What's Left" and guide students in acquiring the information they need.

- Discuss the greater difficulty in finding mineral resources during the second exploration.
- If students did not locate all of the beads and coins, discuss how some mineral resources are difficult to locate.

3. Have students compare what they found to the actual global reserve base shown on the chart of "A Look at What's Left."

B. Ask students whether the world population is increasing. *Yes.* Discuss with students:

- What effect will rapid population growth have on the future availability of nonrenewable natural resources? *Fewer easily accessible natural resources will be available because more people will be using them. More natural resources will need to be harvested, extracted, or mined.*
- What can people do to try to make the natural resources that are readily available last longer? *Slow down the population growth; conserve what is available through reducing, reusing, and recycling.*

C. Have students mix the mineral resources together and have the students pretend that many products were made from these. Ask them the following questions:

- Where can a mix of products from mineral resources like this be found? (Lead students to say in a landfill.)
- What did it take to get these mineral resources into products in the first place? *Acquiring the mineral resources (digging, drilling, transporting), using energy, refining and separating the minerals, manufacturing these resources into products.*
- What is necessary to keep these natural resources in the cycle of use in order to extend their life and usefulness? *Separate them to reuse or recycle; use fewer of them; use them wisely without wasting them.*
- What are the advantages of extending the life of these mineral resources? *Fewer mineral resources and other natural resources will need to be mined or harvested and transported.*

D. Project the transparency of "Depletion Time for Nonrenewable Resources." Lead students to explain what this graph shows.

E. Hand out to each group of students the chart of "Life Expectancies and Main Consumers of Some Nonrenewable Natural Resources." Ask students to complete "A" and "B." When students have completed their assignment, discuss:

- How long are the minerals that are used widely today predicted to last?
- How old will your children or grandchildren be when these resources might be exhausted?
- What effect could the depletion of mineral resources have on your life?

F. Display a large map of the world and/or provide a copy of the handout, "A World Map," to each group. Project on an overhead projector the "Life Expectancies and Main Consumers of Some Nonrenewable Natural Resources." Discuss:

- Why are projected rates of use greater than current rates of use? *It is projected that more people will use more resources.*
- If we use mineral resources at projected rates, will we use them up faster or slower than if we used them at the current level? *Faster.*
- How will an increase in human population affect the rate of use of mineral resources? *The use of mineral resources will increase.*
- What mineral resources are not found in the United States? *Bauxite (from which aluminum is made) and tin.*
- What country(ies) or area(s) has (have) the greatest overall reserves of these resources? *Australia, China, and Indonesia.*

  (Have students find these countries on a large map of the world and/or the handout, "A World Map.")
- What is the United States' present relationships with some of the countries which have these resources? Answers will vary, depending on the country.
- How could our dependence on other countries for mineral resources become a problem? *The people in the country can decide to stop selling the resource to the U.S.*

- What did we learn from this chart? *The people in the United States use a lot of natural resources; many of these natural resources come from other countries.*

DISCUSSION/QUESTIONS

Discuss with students:

- What are the advantages of recycling nonrenewable natural resources? *We can make these last much longer; there will be more for future generations.*
- What are the advantages of recycling renewable natural resources? *Fewer resources will need to be harvested and fewer products will need to be manufactured from raw materials.*
- What are the disadvantages of recycling renewable or nonrenewable natural resources? *People think it is too much trouble to separate their garbage; there may not be nearby markets for some recyclable materials, and transporting these materials may cost too much.*
- What impacts on the environment might the extraction of minerals produce? *Ecosystems, including habitats of plants and animals, are disrupted; there might be air and water pollution.* (Consider having students conduct further research on the impact of mineral extraction.)

APPLICATION

A. Ask students to reread the definitions and examples of renewable and nonrenewable natural resources. Is each accurate? How could you improve the definition?

B. Ask students to name objects in the classroom made from renewable natural resources, nonrenewable natural resources, and those made from both types of resources. *A metal desk is made from nonrenewable minerals; a wooden ruler, from renewable trees; plastic container, from nonrenewable fossil fuels.*

C. Discuss with students:

- What clothing materials come from renewable natural resources? *Cotton, silk, wool, rayon.* Nonrenewable resources? *Polyester, nylon.*
- What packaging materials come from renewable natural resources? *Cardboard.* Nonrenewable resources? *Plastic.*
- How can we as individuals help stem the depletion of nonrenewable resources?

D. Have students write a pledge in which they promise to avoid wasting one specific material at school or at home.

Project Idea: Have students write a class pledge that describes how to avoid wasting natural resources. Organize a school assembly and share the pledge along with information about natural resources.

Project Idea: Have students design posters or a bulletin board showing pictures of renewable and nonrenewable natural resources and ways they can be conserved. (If posters will be done, then this can be assigned as homework.) These can be displayed at school and in other public areas.

EXTENSIONS

A. Assign students to come up with substitutes for resource materials that are in short supply. Ask them to identify what characteristics substitutes would have to have to replace aluminum, iron ore, lead, plastics, paper, and tin.

B. Assign students to research the potential for mining minerals beneath the oceans. Who "owns" these minerals?

RESOURCES

Video

Conserving Our Natural Resources. Chatsworth, Calif.: AIMS Media, 1979 (15 minutes)

Describes natural resources and the importance of conserving them.

Videodisc

Windows on Science: Physical Science. Volumes 2 and 3, Energy Resources. Atlanta, Ga.: Optical Data School Media, 1993.

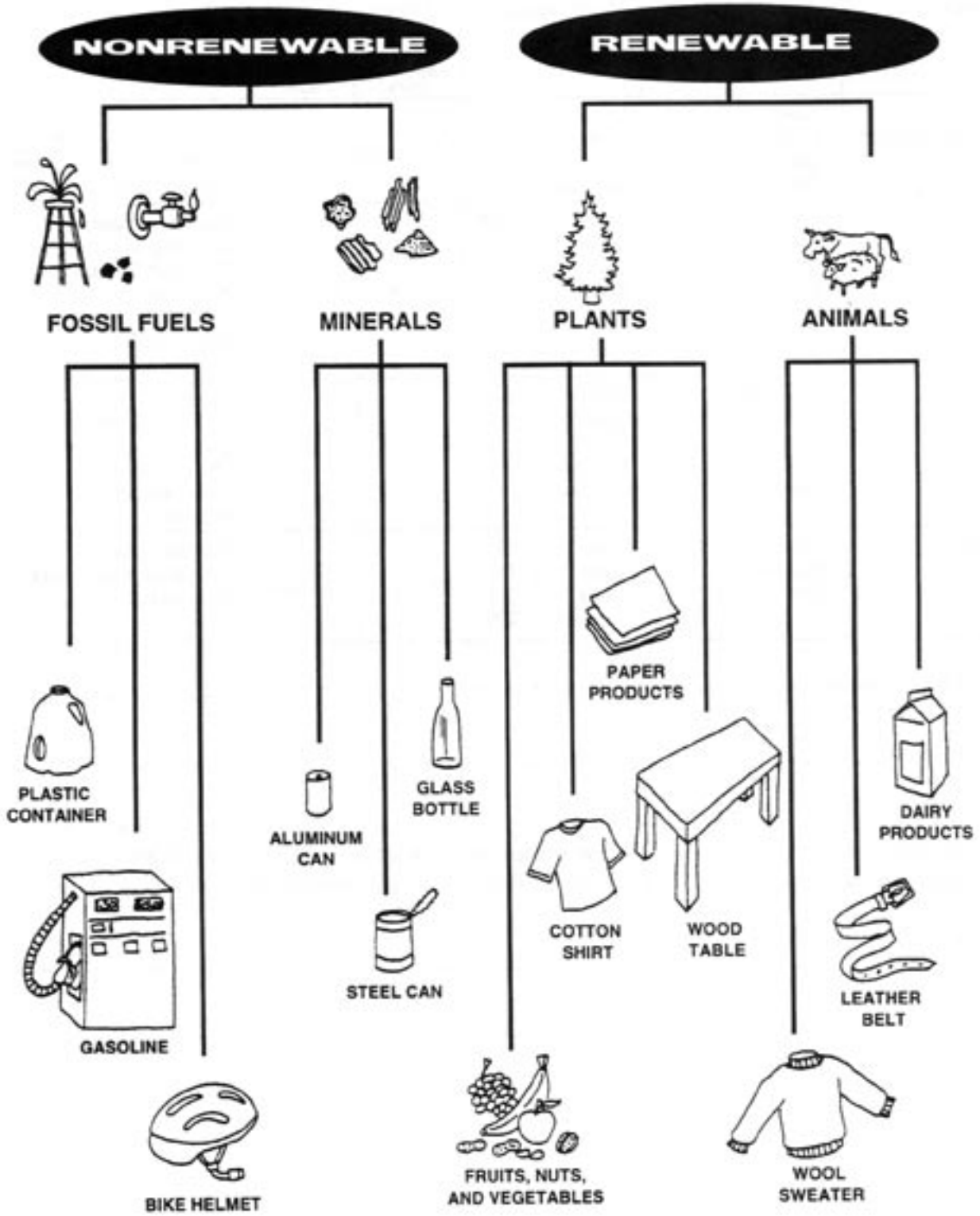
A multimedia science program that guides students to compare various renewable and nonrenewable resources.

Web sites

See "Appendix F–IV, Natural Resources Web sites."

Transparency

SOME OF THE EARTH'S NATURAL RESOURCES



Transparency and Student's Page

LIFE EXPECTANCIES AND MAIN CONSUMERS OF SOME NONRENEWABLE NATURAL RESOURCES[1]

Resource	Countries or areas with highest mine production 1998		Main consumers 1997		Life expectancy in years		Amount recycled in US in 1997
					If used at current level (1997)	If used at projected rates	
Aluminum in bauxite	Australia Guineas Jamaica Brazil	38% 12% 10% 8%	USA Japan China Germany	26% 12% 10% 7%	276 years	63 years	No bauxite recycled in US; 67% of aluminum cans are recycled.
Iron in ore	China Brazil Australia Russia India USA Canada	25% 18% 14% 7% 7% 6% 3%	China Japan USA Russia	36% 12% 8% 7%	150 years	62 years	There is no significant recycling of iron ore. However, 58 million metric tons of steel were made from scrap metal.
Lead	Australia China USA Peru Canada	18% 15% 15% 8% 6%	USA China United Kingdom Germany	27% 8% 6% 6%	23 years	15 years	1.1 million tons recovered from old (post-consumer) scrap; 990,000 tons were recovered from used batteries.
Tin	China Indonesia Peru Brazil	30% 20% 14% 10%	USA Japan China Germany	18% 16% 13% 10%	35 years	25 years	11,000 tons from old and new scrap were recycled in 1997.

A. List the main consumer of each resource. Aluminum: _____

Iron ore: _____ Lead: _____ Tin: _____

B. If consumption grows at projected rates, which mineral resource will be the first to be depleted? List the next three mineral resources in order of depletion rate. Bonus: Next to each number, list how old you will be when the mineral resource is depleted.

1. _____

2. _____

3. _____

4. _____

[1]"Mineral Commodity Summaries 1998." USGS Minerals Information. From Web site: http://minerals.er.usgs.gov/minerals/pubs/mcs/1998; World Bureau of Metal Statistics, Metal Statistics 1986–1996.

Transparency and Student's Page

A LOOK AT WHAT'S LEFT

Color	No. of beads	Finite resource	1998 estimate of global reserve base*
Red	420	Iron in ore	112 billion metric tons
Blue	105	Bauxite	28 billion metric tons
Yellow	1	Tin	12 million metric tons
Silver coin	1	Silver	420,000 metric tons
Copper coin	3	Copper	630 million metric tons
Orange	1	Lead	120 million metric tons
Purple	30	Chromium	7.5 billion metric tons
Green	1	Platinum	77,359 metric tons

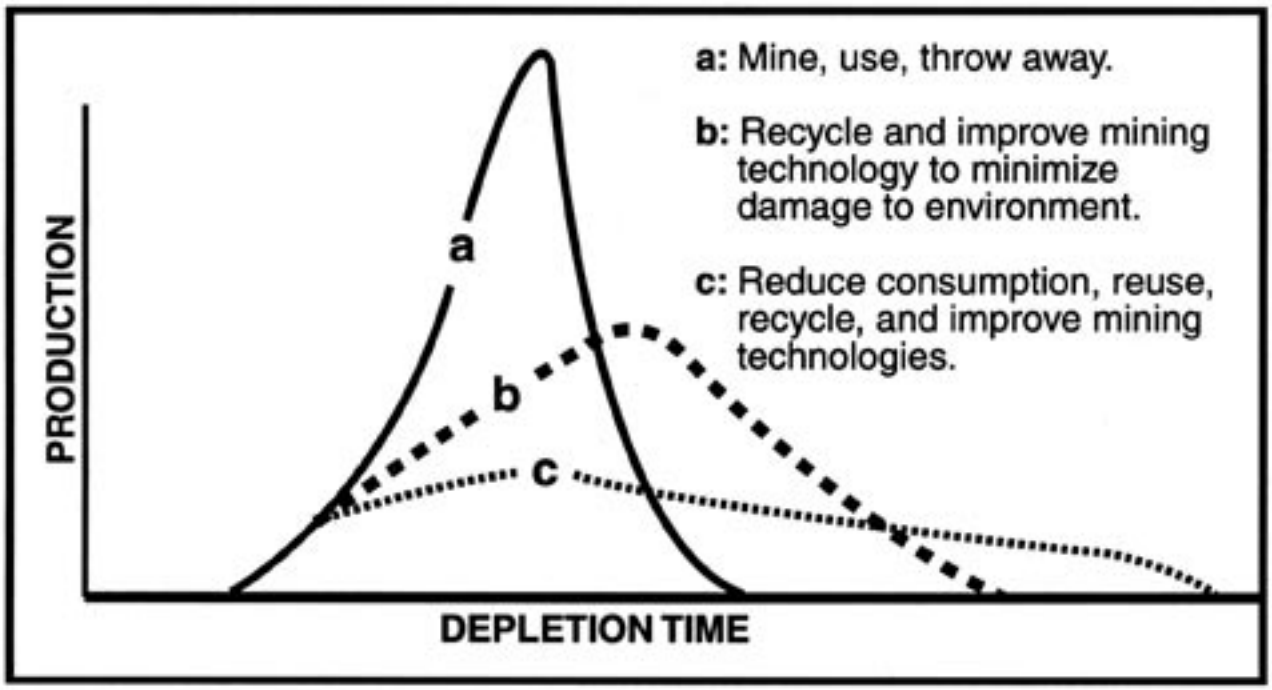
*"The reserve base includes those resources that are currently economic (reserves), marginally economic (marginal reserves), and some that are currently subeconomic (subeconomic resources). Source of figures is: "U.S. Geological Survey, Mineral Commodity Summaries, January 1998."

Note: Metric ton = 2,200 lbs.

Note: The number of beads reflects a mineral's relative, estimated total abundance—not the ease of extraction or potential availability of that mineral. The beads are not distributed in exact percentages to allow for hypothetical and undiscovered resources.

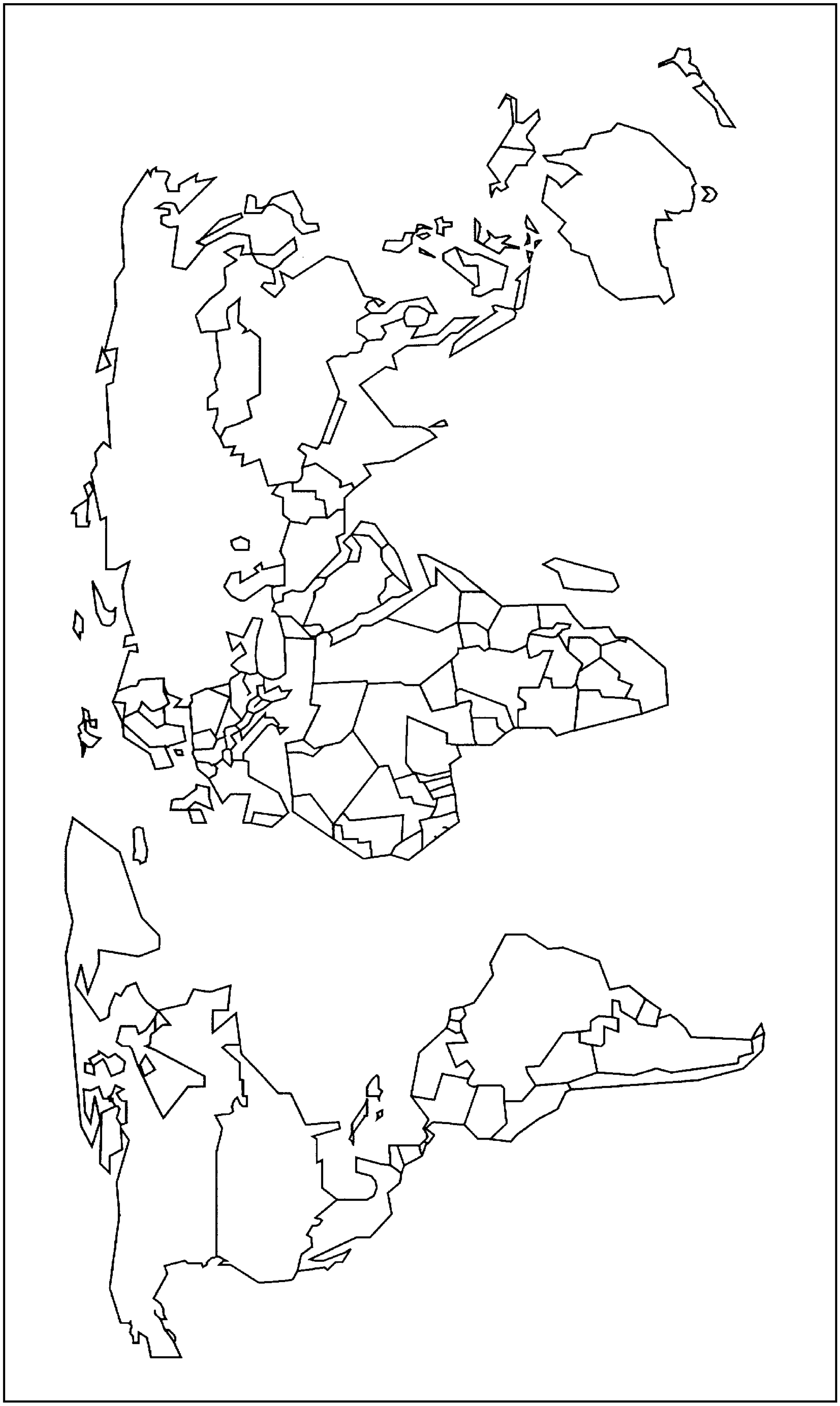
Transparency

DEPLETION TIME FOR NONRENEWABLE RESOURCES



Transparency and Student's Page

A WORLD MAP



4–6 Module
Unit 1

BACKGROUND INFORMATION FOR THE TEACHER

Natural resources used by humans can be classified as renewable and nonrenewable. Renewable natural resources are those which can be replaced within a human lifetime over and over again. Nonrenewable natural resources are those that may take millions of years to be replaced; therefore, people can rely only on those deposits already in existence.

Scientists consider natural resources to be renewable if they are replaced naturally or through human-assisted actions within a relatively short amount of time. For example, plants, such as trees, can be replanted indefinitely as long as the trees are selectively cut, the soil in which these trees grow are protected from erosion, and the diversity of the forest is kept in tact.

Other renewable natural resources are animals, because they can reproduce and have young; water, because the water cycle keeps recycling water; and air, because plants and animals recycle the air through respiration.

Renewable natural resources, such as water and trees, can last indefinitely if people (or natural disasters) do not disrupt the systems that sustain them. For example, water sources need to be protected from pollution and from depletion that exceeds replenishment by the water cycle. Trees must have their life requirements met—healthy soil, stable climatic conditions to which species have adapted, adequate carbon dioxide and water to perform photosynthesis, and conditions that foster reproduction of new trees. However, trees can become finite resources if the demands for them outpace the period needed for natural regrowth and the balance with other components in their ecosystem is disrupted.

Nonrenewable resources are those replenished through extremely slow natural cycles (fossil fuels) or which for all practical human purposes are not replenished at all (some mineral deposits). "Although mineral resources are continually being formed by geologic processes, the rate is so slow that we can rely only on those deposits already in existence. The current rate of mineral use far exceeds the rate of formation. Mineral resources are thus considered nonrenewable."[2]

World mineral use increased tenfold from 1750 to 1900. Since 1900 world mineral use has increased thirteenfold.[3] The future supply of nonrenewable natural resources depends on the actual or potential supply and the rate at which the supply is used.[4]

Some people believe that the Earth is so rich in natural resources that there are actually plenty of natural resources available—but for a price. That price may be using even more energy and more equipment and contributing to even greater environmental degradation to get less easily obtained natural resources from the Earth (e.g., drilling for oil or other extracted materials in natural parks or fragile ecosystems). Other people believe this is not a reasonable choice, because the cost to the environment exceeds the benefit of the relatively small amount of material that would be extracted.

Before we would run out of a nonrenewable natural resource, it is likely that the economic costs of extracting it would become greater than the extracted material would be worth. Alternate materials would need to be discovered.

Potential desirable strategies for extending the life expectancy of nonrenewable resources include:

- Using recycled materials rather than raw materials whenever possible in the manufacturing process
- Substituting products made from renewable resources for products made from nonrenewable resources
- Having consumers examine the necessity for their use of natural resources and reducing their use wherever possible

Waste can be considered both renewable and nonrenewable. Waste contains many materials that can be reused or recycled. It also contains materials that cannot be put to any useful purpose again.

The proper management of both waste and natural resources will help to keep our environment healthy and provide a continuous supply of natural resources we and other living things need in order to live.

[2]Melissa Ballard and Mamata Pandya, *Essential Learnings in Environmental Education*. Washington, D.C.: North American Association for Environmental Education, 1990, p. 78.

[3]G. Tyler Miller, Jr., *Environmental Science: Working with the Earth* (Fifth edition). Belmont, Calif.: Wadsworth Publishing Company, 1995, p. 313.

[4]*Ibid.*, p. 312.

LESSON 5: Ways to Conserve Natural Resources

LESSON'S CONCEPTS

- Reducing, reusing, and recycling materials help to conserve natural resources.
- The quality of the lives of future generations may depend on people's use of natural resources today.

PURPOSE

Students will identify ways to conserve natural resources in their classroom and will provide this information to others at school.

OVERVIEW

In this lesson students will:

- Write a letter from the viewpoint of a person living in the future, thanking this generation for conserving natural resources.
- Conduct a class meeting to obtain and select ideas to conserve natural resources in the classroom.
- Write an advertisement or design a poster to encourage people to conserve natural sources.
- Implement the plan they agreed on to conserve natural resources in the classroom.
- Identify some ways that natural resources can be conserved at the entire school.

CORRELATIONS TO CALIFORNIA'S CONTENT STANDARDS AND FRAMEWORKS

- Students write a letter from the viewpoint of a person living in the future, thanking this generation for conserving natural resources.
  - Students "write narratives [that] relate ideas, observations, or recollections of an event or experience [and] provide a context to enable the reader to imagine the world of the event or experience." *(English–Language Arts Content Standards for California Public Schools, Kindergarten Through Grade Twelve*, page 24)
- Students present and compare ideas for conserving natural resources in the classroom.
  - "All resources used by humans, including fuels, metals, and building materials, ultimately come from the Earth. Many of these resources are not in endless supply. They have taken many thousands and millions of years to develop and accumulate. They must be used with care, conserved, and recycled." (*Science Framework*, page 97)
  - "Students listen critically and respond appropriately to oral communication. They speak in a manner that guides the listener to understand important ideas by using proper phrasing, pitch, and modulation." *(English–Language Arts Content Standards for California Public Schools, Kindergarten Through Grade Twelve*, page 26)
- Students discuss how the plan selected to conserve natural resources in the classroom reflects our values and assumptions.
  - "Students deliver brief recitations and oral presentations about familiar experiences or interests that are organized around a coherent thesis statement." *(English–Language Arts Content Standards for California Public Schools, Kindergarten Through Grade Twelve*, page 27)
  - "To understand why individuals and groups acted as they did, we must see what values and assumptions they held, what they honored, what they sought, and what they feared." (*History–Social Science Framework,* page 13)

- Students discuss the meaning of the story, *Why the Sky Is Far Away*, retold by Joan-Mary Gerson that they hear or read.
  - Students "identify structural patterns found in informational text (e.g., compare and contrast, cause and effect, sequential or chronological order, proposition and support) to strengthen comprehension." *(English–Language Arts Content Standards for California Public Schools, Kindergarten Through Grade Twelve*, page 22)

SCIENTIFIC THINKING PROCESSES

observing, communicating, comparing, relating, applying

TIME

15 minutes to prepare for the lesson; 90 minutes to implement the lesson

VOCABULARY

conservation

PREPARATION

___ Read the "Background Information for the Teacher" on page 308.

MATERIALS

___ The book, *Why the Sky Is Far Away*, retold by Joan-Mary Gerson
___ Art materials for posters

PRE-ACTIVITY QUESTIONS

A. Write the following statement on the chalkboard: "The lives of future generations depend on people's use of natural resources today." Discuss with students what that statement means.

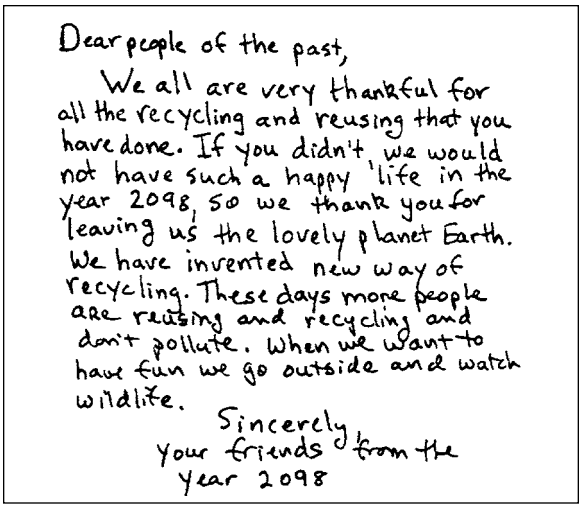
B. Ask students to write a letter from the viewpoint of a person living in the future (e.g., in the year 2100), thanking this generation for conserving natural resources. In the letter students should describe what types of things the person living in the future gets to do, because all natural resources are available. Tell students to be specific on what actions this generation took to make sure that future generations had plenty of natural resources for their lives. They should also include how their actions helped to preserve habitat for plants and wildlife.

Note: For younger students, you might wish to write this letter together.

PROCEDURE

A. Read to students *Why the Sky Is Far Away*, retold by Joan-Mary Gerson (or have each student read a section as the book is passed from student to student or have students read the book in pairs at a reading center). Students can write or discuss in pairs, groups, or as a class the answers to the following questions:

- What is the chronological order of events in this story? *People first got food whenever they wanted it without doing any work. They celebrated and danced and began wasting food. Then they no longer had food in the sky to eat whenever they wanted to; they had to work for their food by planting and harvesting crops.*
- What was the cause and effect in this story? *People got greedy and wasted food. Now they have to work for their food by planting and harvesting crops. This will probably keep them from wasting food.*
- What is the meaning of the story? *It tells us the importance of appreciating and caring for what we have; not to be greedy or lazy or to waste food.*


Dear people of the past,
We all are very thankful for all the recycling and reusing that you have done. If you didn't, we would not have such a happy life in the year 2098, so we thank you for leaving us the lovely planet Earth. We have invented new way of recycling. These days more people are reusing and recycling and don't pollute. When we want to have fun we go outside and watch wildlife.
Sincerely,
your friends from the year 2098

Submitted by Ed Malaret, fifth-grade teacher, Marguerite Hahn Elementary School, Cotati–Rohnert Park Unified School District.

- How does this story apply to people's use of natural resources? *If we appreciate and conserve natural resources, we should have the resources we need to live, and future generations will also have resources to use.*

B. Discuss with students:

- How are we already conserving natural resources in the classroom? *We have a box for used paper so we can reuse it, and we have a box for aluminum cans to be recycled.*
- How are we not conserving natural resources in the classroom? *We still have a lot of waste that ends up in our trash can.*

C. Tell students that they will work with partners or in groups of three to come up with a plan on what else can be done in the classroom to conserve natural resources.

1. As a class, make a list of parts and guidelines that each plan should contain. For example the plan should:

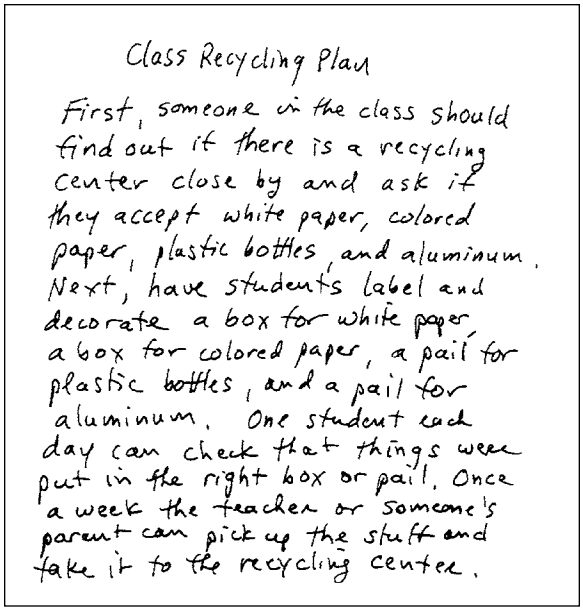
- Be easy to follow.
- Indicate who will be responsible for making the plan happen.
- Describe what should be done if the people responsible for making the plan happen will not or cannot do it.
- Describe what natural resources will be conserved.
- Support why you think this plan is the best idea.

Note: For younger students consider developing a plan as a class.

2. Ask students to meet in pairs or groups of three. Allow about 15 to 20 minutes for students to work on their plans. Then have each group present its plan to the class.

3. After all groups have made presentations, students can support their favorite plan by describing their reasons to the class. Then the class can decide which plan or a combination of plans to implement.

4. A month later, discuss with the students whether the plan is working and have them recommend adjustments to the plan, if needed.



Class Recycling Plan

First, someone in the class should find out if there is a recycling center close by and ask if they accept white paper, colored paper, plastic bottles, and aluminum. Next, have students label and decorate a box for white paper, a box for colored paper, a pail for plastic bottles, and a pail for aluminum. One student each day can check that things were put in the right box or pail. Once a week the teacher or someone's parent can pick up the stuff and take it to the recycling center.

Submitted by Janet Cohen, sixth-grade teacher, Gold Trail Elementary School, Gold Trail Union School District.

DISCUSSION/QUESTIONS

- Why are natural resources valuable? *We depend on them to live; we use them for things we need and want; other living things need them to survive.*
- Why is conserving natural resources important? *It saves natural resources for future generations; it keeps more natural areas from being mined or forests from being overcut; it keeps natural resources from ending up in a landfill.*
- How does the plan that the class selected to conserve natural resources in the classroom reflect our values? *We value natural resources because we have learned how important they are to our lives.*
- How can you conserve natural resources at home? *Reduce, reuse, recycle. If you buy less, you are conserving resources; if you reuse or recycle, you are extending the life cycle of the object and therefore conserving natural resources.*
- Where do we see natural resources being wasted? *At home and at school and in the community, when people throw things away that can be reused or recycled, and when people buy things they don't really need and then throw them into the trash can.*
- Where might waste be generated at school? *In the classroom, in the offices, in the cafeteria, on the school grounds.* Where do we see natural resources being wasted at school? Do we want to do anything about it? Why or why not?

APPLICATION

A. Ask students to write an advertisement or design a poster to encourage people to conserve all natural resources or a specific natural resource.

Homework Assignment: Ask students to write about the following: What would your life be like if you and everyone else always reduced, reused, and recycled materials? For extra credit, describe what your community would be like if everyone reduced, reused, and recycled materials.

B. Have students share in groups their homework assignments.

C. Ask students to relate their plan to conserve natural resources in the classroom to ways natural resources can be conserved in the entire school.

D. Discuss with students what else can be done to conserve natural resources, other than reducing, reusing, and recycling. For example, buy recycled items. (This topic is addressed in the 4–6 Module, Unit 2, Lesson 8.)

Project Idea: Develop and implement a plan to reduce waste at school.

EXTENSION

Have students look at the time line "History of Waste Management" (see "Appendix B–I"). Ask students to write a future time line, including changes in the wasteful use of natural resources and in the reduction of trash.

RESOURCES

Videos

Get Busy: How Kids Can Save the Planet. Pleasantville, N.Y.: Sunburst/Wings for Learning, 1992 (30 minutes).

Gives practical suggestions for improving the environment. Shows students taking part in reducing pollution and cleaning up their environment.

Reducing, Reusing, and Recycling. Environmental Science series. Northbrook, Ill.: Film Ideas, Inc., 1990 (20 minutes).

Focuses on the problems created by solid waste and offers ways to help alleviate these problems.

You Can Make a Difference. Washington, D.C.: The Discovery Channel and the National Wildlife Federation, 1990 (25 minutes). Available from the National Wildlife Federation.

Addresses ways to cut waste, reduce the use of toxic chemicals, conserve energy, save water, clean the air, and protect endangered species and wildlife habitat.

Books

Kid Heroes of the Environment. Edited by Catherine Dee. Berkeley: Earth Works Press, Inc., 1991.

Describes what individual students are doing nationwide to help improve the environment.

Why the Sky Is Far Away. Retold by Mary-Joan Gerson. Illustrated by Carla Golembe. New York: Little, Brown and Company, 1992.

A tale from Nigeria about the importance of respecting nature's gifts.

Websites

For ideas for projects, activities, and awards, see "Appendix F–I, Awards and Activities websites."

BACKGROUND INFORMATION FOR THE TEACHER

To conserve natural resources is to protect or use them knowledgeably without wasting them or using them up completely. Conserving natural resources can make them last and be available for future generations.

Natural resources can be made to last longer in the following ways:

- Having people reduce the number of things they buy and use whenever possible
- Having people reuse items as much as possible
- Having people buy things in reusable or recyclable containers
- Using recycled materials rather than raw materials in the manufacturing process whenever possible
- Having people buy products made from recycled materials